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UNITED STATES DEPARTMENT OF AGRICULTURE

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Report of the

ALLEGHENY FOREST EXPERIMENT STATION*

January 1, 1932 - December 31, 1934

*Maintained at Philadelphia, Pa., in cooperation with the University of Pennsylvania.

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PART I

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Membership

ALLEGHENY FOREST RESEARCH ADVISORY COUNCIL

1932

F. W. Besley, State Forester, 1411 Fidelity Building, Baltimore, Maryland.

George W. Butz, Jr., Butz Lumber Company, Wilmington, Delaware.

Egbert S. Cary, Superintendent, Pocono Lake Preserve, Moorestown, New Jersey.

E. O. Ehrhart, Armstrong Forest Company, Johnsonburg, Pennsylvania.

Professor J. A. Ferguson, Department of Forestry, State College, Pennsylvania.

Dr. O. E. Jennings, Curator of Botany, Carnegie Museum, Pittsburgh, Pennsylvania.

Henry W. Leeds, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

Dr. J. G. Lipman, Director, New Jersey Experiment Station, New Brunswick, New Jersey.

Louis C. Madeira III, Madeira Hill & Company, 260 South Broad Street, Philadelphia, Pennsylvania.

A. J. Musser, General Manager, Clearfield Bituminous Coal Corporation, Indiana, Pennsylvania.

E. C. M. Richards, Box 525, Media, Pennsylvania.

Lewis E. Staley, Secretary, Department of Forests and Waters, Harrisburg, Pennsylvania.

DeCourcy W. Thom*, Maryland Trust Building, Baltimore, Maryland.

Dr. Rodney H. True, Department of Botany, University of Pennsylvania, Philadelphia, Pennsylvania.

Captain Alexander R. Wheeler,* Wheeler & Dusenbury Lumber Company, Endeavor, Pennsylvania.

Ezra B. Whitman, Baltimore Trust Building, Baltimore, Maryland.

C. P. Wilber, State Forester, Trenton, New Jersey.

*Deceased

PERSONNEL ALLEGHENY FOREST EXPERIMENT STATION

1932-1934

PERMANENT STAFF

FOREST SERVICE

Forbes, R. D.	Director	
Schnur, G. L.	Associate Silviculturist	
Hough, A. F.	Assistant Silviculturist	
Wood, C. M.	Assistant Silviculturist	
Hatch, A. B.	Assistant Silviculturist	Resigned 6/4/32
Morey, H. F.	Junior Forester	Transferred 10/31/31
Ackerman, P. E.	Ranger	Appointed 5/20/32
Skamser, C. E.	Senior Clerk	
Evans, M. R.	Senior Stenographer	
Loose, H. V.	Assistant Statistical Clerk	

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Jackson, L. W. R.	Assistant Pathologist in Charge
Doak, K. D.	Assistant Pathologist

TEMPORARY EMPLOYEES*

E. C. W. and N. I. R. A.

FOREST SERVICE

McComb, A. L.	Junior Forester - Field Assistant
McQuilken, W. E.	Technician
Mollenhauer, Wm., Jr.	Technician
Randall, A. G.	Technician
Simmons, E. M.	Technician
Andrews, S. R.	Assistant to Technician
Hazen, J. F.	Assistant to Technician
Howard, R. H.	Assistant to Technician
Niederhof, C	Assistant to Technician
Ogloblin, K. A.	Assistant to Technician
Turberville, H. W.	Assistant to Technician
Wilkinson, R. M.	Assistant to Technician
Chalfant, J. W.	Field Assistant
Kimberly, J. T.	Field Assistant
Melick, M. A.	Field Assistant
Pilmer, H. E.	Field Assistant
Yetter, H. S.	Field Assistant
Yocum, L. E.	Field Assistant

BUREAU OF PLANT INDUSTRY

Dr. N. A. Norton
Dr. Bailey Sleeth
Isador Aaron

*Average period of employment for the Forest Service slightly exceeded $3\frac{1}{2}$ months. For the B. P. I. it was 9 months.

(In addition there were employed, for short periods and from a variety of emergency funds, as many as 17 laborers and 19 office and laboratory employees. The working period for the temporary office and laboratory help averaged somewhat less than three and a half months.)

SUMMARY OF ACCOMPLISHMENTS

The last progress report of the Station mimeographed for general distribution covered the calendar year 1931. Pressure of emergency work and reduced regular appropriations have prevented the preparation of subsequent annual reports. The following statement summarizes in chronological order the chief accomplishments of the Station during 1932, 1933, and 1934.

ADMINISTRATION

Removal of the branch station in the oak-pine forest of southern New Jersey from Camp Ockanickon to a larger and more typical experimental forest on the Lebanon State Forest, and the erection at that point of a larger field laboratory and bunk house, with a garage, water and sewage system, and electric connection.

Erection at the headquarters of the Kane Branch Station (Kane, Pa.) of additional buildings to accommodate members of the Philadelphia staff during the field season, and to provide garage space.

Erection of a fifty-foot greenhouse on the campus of the University of Pennsylvania at Philadelphia, to relieve pressure on the University for greenhouse space for our work, particularly that in pathology.

RESEARCH IN SILVICULTURE

Management of Allegheny Hardwoods (Project M-1)

Publication of tentative proof that the solid content of a cord of distillation wood is not appreciably influenced by the size of the tree from which it is obtained, provided the larger wood is split.

Publication of evidence that in the virgin forests of the Allegheny territory white pine, unlike several associated species, occurred in essentially even-aged stands, suggesting an origin in catastrophes destroying the previous stands.

The establishment of 15 permanent yield plots of the Allegheny hardwoods type in the Kane Experimental Forest.

Establishment of eight acres of permanent plots - in addition to those just mentioned - in the Kane Experimental Forest, for an investigation of the best methods of thinning Allegheny hardwoods. The study was undertaken in close connection with the C.C.C. program of stand improvement in the surrounding Allegheny National Forest.

Preparation of a detailed ecological description of the virgin timber on Tionesta Creek, Allegheny National Forest, and publication of a popular article emphasizing the value for scientific study of this and other virgin timber.

The successful culmination of the Station's campaign, through the Pennsylvania Forestry Association, to preserve a portion of the Tionesta Virgin Forest for scientific research. The National Forest Reservation Commission approved acquisition by the Forest Service of about 3500 acres of this virgin hemlock-northern hardwoods tract.

Establishment of 10 permanent sample plots in a portion of the Tionesta Forest about to be logged and adjacent to the area purchased. The purpose was to reconstruct, from stump age counts and other evidence, the ecological history of this type of forest, and to deduce from it silvical and silvicultural principles to be applied in second-growth forests.

Management, Coastal Plain Forests (Project M-3)

Substantial progress in a study of the root habit of chestnut oak and pitch pine in southern New Jersey. The entire root system of a sapling oak was hydraulically excavated down to the finest rootlets, photographed root by root, and its position relative to the crown mapped. The leaf surface was

measured, and the dry weight of leaves, stem, and roots obtained. This work, described in a preliminary paper, is perhaps the most complete record ever obtained of the gross anatomy of an American tree. The pitch pine study was less intensive so far as the individual trees were concerned, but covered the root systems of a series of trees, from seedlings to mature specimens. The typical development of the root system of this species with increasing age is clearly demonstrated in a paper prepared for publication.

Completion for publication of an article on the seed production of chestnut oak in southern New Jersey.

Mensuration, oaks (Project ME-1)

Completion of yield, stand, and volume tables for even-aged upland oak forests of the eastern United States, and submission of a Departmental bulletin to accompany them. This is the final outcome of a study begun over 10 years ago at the Appalachian Station, and to which the Central States Station has contributed very substantially.

Mensuration, Coastal Plain (Project ME-2)

Completion for publication of a paper describing improved methods of constructing stand tables. The included stand tables for loblolly pine on old fields are believed to be more correct than any similar stand tables so far published.

Minor projects

Preparation of a paper on the influence of forests on local climate in the Station territory, and publication of a popular article on the present state of our knowledge concerning forest influences in the United States.

RESEARCH IN FOREST PATHOLOGY

Mycorrhiza (Formerly our project Pd-1, now B.P.I. project 6P)

Demonstration of the character and manner of occurrence of true and false mycorrhiza - the close association of the hyphae of certain soil fungi - with the roots of some kinds of seed-plants - on the roots of pines, in contrast with their normal anatomy. Some misconceptions which had slowed down progress in the understanding of the mycorrhizal association were corrected, and a firmer basis for future research was laid in a joint paper published through the Arnold Arboretum.

In connection with the work on mycorrhiza a technique was evolved for growing seedlings for long periods in pure culture chambers, with or without inoculation by mycorrhiza-forming soil fungi.

A pure culture collection of 121 species of suspected mycorrhizal fungi was built up from isolations obtained under natural forest conditions. Each of 18 different species of these fungi have been found to form mycorrhiza with at least one, but often with more of 11 species of trees.

The significance of mycorrhizae to shade trees was discussed before a meeting of the "National Shade Tree Conference" and an account published in their proceedings.

Nursery Diseases (B.P.I. project 2P)

Studies showing the degree of acidity or alkalinity of the soil to be largely responsible for the damping-off diseases of conifer seedlings. The smallest loss occurred at the lowest pH values. In consequence considerable progress was made in the treatment of damping-off.

Determination of the way in which coniferous seedlings become infected with the various types of damping-off, showing the disease to be in reality a root rot.

The discovery, resulting from a search for suitable fungicides to combat damping-off of red and white pine seedlings in the Delaware State Forest Nursery, that formaldehyde is the most effective control agent and hence a considerable reduction of the losses in nurseries.

The discovery that the fungus Phytophthora cinnamoni is responsible for a new disease in one of the Region's nurseries. This disease, a root and collar rot, has proven to be very destructive, chiefly to red pine seedlings and transplants. It is suspected of being an introduction, and therefore dangerous. It has not been found elsewhere in the Alleghany territory so far. The growing of red pine at this nursery has since been discontinued.

An investigation of a severe case of root trouble amongst the red and white pine beds in the New Jersey State Nursery at Washington Crossing, perhaps partly due to drought but, from all appearances, mostly to a root rot.

The establishment of sulphuric acid and aluminum sulphate as affording adequate control for the severe cases of damping-off ravaging the seedbeds in the Monongahela Nursery at Parsons, West Virginia.

A culture study and several series of pot tests with various fungicides, run jointly with Professor Perry of the Pennsylvania State Forestry School, to determine the parasites responsible for and the means of controlling the serious damping-off diseases occurring at the Mont Alto nursery.

The finding, as a result of experiments involving nearly 1,000 cultures, of a hitherto unknown fungous parasite unusually tolerant of high acidities. This fungus was responsible for most severe losses during 1933 and '34 in the seedbeds at the New Jersey State Nursery, including the total destruction of the red and Scotch pine seedlings. The parasite was found to be very destructive to most species of conifers and did not respond to the usual treatments.

The discovery that salicylic acid apparently is an effective fungicide against damping-off.

The preliminary development of a method to determine the rate of application of acidifying agents to change the reaction of nursery soils, down to any depth, to any desired pH.

The discovery of several new nursery diseases, the study of their origin, causation, spread, and control, and the building up of an extensive culture collection.

The diagnosis of a severe root rot amongst tulip poplar seedlings at the Monongahela Nursery, Parsons, West Virginia, and bringing it under control by the measures recommended.

Extensive cooperation and service activities with numerous educational institutions, State and private nurseries, and various other organizations.

Disease Survey (B.P.I. project 1P2)

Discovery of several new forest tree diseases as a result of investigations following reports of more or less severe damage or uncommon rates of dying off in various areas, and of a preliminary survey made in the territory in 1934, of forest lands where improvement cuttings were being made by the CCC. The principal ones amongst these are:

(a) A very serious resinosis disease amongst the white and red pine plantings at the Nolde Estate, Reading, Pa.

(b) A twig and stem canker disease amongst certain hard pines, caused by fungi of the Atropellis group and responsible for damage in the Scotch pine plantations at the Mont Alto Nursery, Pa., and in young loblolly pine stands in Delaware.

(c) A canker disease, due to a Nectria fungus, prevalent throughout the Region.

(d) A brooming disease on black locust over its entire range.

(e) Severe dying-off, probably due to drought, in the pine plantations around York, Pa.

(f) A blue spruce resinosis disease in the Philadelphia area.

(g) Widespread dying of the plane trees (Platanus orientalis) in the western suburbs of Philadelphia, Pa., especially in Delaware County.

(h) Dying of Himalayan pine (Pinus excelsa) in the Philadelphia area.

(i) Dying of Austrian pine (Pinus austriaca), probably due to a twig blight, around Philadelphia, Pa.

General Inquiries on Tree Diseases (B.P.I. project 1P1)

The answering of general inquiries - the number of which is rapidly increasing - from individuals, public as well as private institutions and organizations, on the diseases found in a great variety of shade and forest trees.

Decay of Sprout Hardwoods (B.P.I. project 3P)

The study of the butt-rots in the second-growth hardwoods - chiefly oaks - of the Allegheny Region, although greatly retarded by a lack of logging due to the depression, has revealed the nature of many of the fungi responsible for both the heart and sap rots and their occurrence in the Station territory. Emphasis has been laid on the question as to how decay is transmitted from dead sprout to living companion sprout and from the parent stumps to the sprouts. In many sprout groups with one or more sprouts long since dead, the decay had entered the crotch of the dead sprouts but was found in most cases to end a short distance below. In others it had entered the living sprout

through a fire scar or through the parent stump but had died before going very far up the sprout. Decay transmission from dead or cut sprouts in the groups examined was surprisingly rare.

To determine the economic and pathological effect of butt rot several 1/4-acre plots and logging operations were studied for the percentage of its occurrence amongst various growth conditions. Stereum gausapatum has been found to be the most common decay organism in the infected sprout hardwoods of the Region. In eight 1/4-acre plots in stands averaging from 16 to 35 years its prevalence was 0 to 18%. Only one of the logging operations, that at McAlevys Fort, yielded data perhaps typical of sprout reproduction stands. The economic loss due to butt decay in the fire-free, 80-year-old stand with a 90 to 100% sprout reproduction was found not to be high. Late in 1933 the project was taken over by the ECW, and the field work has since been carried on by Dr. Sleeth. In December, 1934, it was transferred to the Washington office.

A MORE DETAILED ACCOUNT OF THE STATION'S WORK

ADMINISTRATION

Personnel

The loss of Assistant Silviculturist A. B. Hatch and Junior Forester H. F. Morey reduced the permanent technical staff of the Forest Service to four men, and was a serious handicap to progress in the mycorrhiza and Allegheny hardwoods projects. The Economy Act and cuts in the Station funds prevented filling of the vacancies.

Senior Forest Ranger P. E. Ackerman, transferred from Region Seven, became the year-long superintendent of the Kane Branch Station in 1932.

The assignment of temporary funds to the Station has made possible the employment of a substantial number of technicians for varying periods. Valuable as this assistance was, it cannot be compared with the services which these men might have rendered if employed permanently. A large turn-over in personnel is particularly demoralizing in long-term research work.

Advisory Council

In 1932 two Council meetings were held. That in January at Atlantic City approved the program of the Station for the ensuing year, and the second meeting, held in June at Kane, enabled the members to become personally acquainted with the virgin timber area of East Tionesta and the Kane Experimental Forest.

In 1933 there was one meeting on May 24. This was a program meeting, and was held at the Morris Arboretum, recently willed to the University of Pennsylvania.

Lack of activity on the part of the Council during the last few years is the direct result of the Secretary's inability to give enough time to Council affairs.

Branch Stations

Kane. This Branch was formally established in June, 1932, by the employment of a resident superintendent. Emergency funds for unemployment relief made possible the erection of a resident superintendent's house, a combined laboratory and mess-hall, two small staff dwellings, a workshop, a three-car garage, and the necessary sewerage and water system. Natural gas is obtained from a nearby pipe line, but electricity had to be generated locally.

These funds also enabled the construction of an intensive system of fire protection for the experimental forest. This included 4.7 miles of fire line on exposed boundaries, the removal of ties from 2.3 miles of old railroads, and the brushing out and reasonable repair of 12 miles of old wagon roads. Through the cooperation of Supervisor Bishop a fire crew was organized for this area. The Seven Mile road and the road built by us between the headquarters and Dahoga were included by the Forest in its highway system. Two-miles of telephone line were built to connect headquarters with a commercial line near Lamont, the National Forest donating both poles and wire.

Three meteorological stations were promptly established on the Forest. The control station in a 5-acre clearing was equipped with an anemometer on a 55-foot standard Weather Bureau tower, with a hygro-thermograph, rain and snow gauges, and maximum and minimum thermometers. Two other stations, less completely equipped, were set up in a small area of old growth, and in a dense second-growth stand. In 1934 a fourth meteorological station was established in a "frost pocket".

Civilian Conservation Corps labor was generously furnished us for road repair and other purposes.

Southern New Jersey. Inevitably increased use for recreation of the area assigned to us at Camp Ockanickon made it desirable to move our south Jersey Branch Station elsewhere. The New Jersey Board of Conservation and Development early in 1934 leased us 525 acres of comparatively well-timbered land at the north end of the Lebanon State Forest, well situated with respect to fire protection. More intimate knowledge of the south Jersey conditions than was possible in 1927 when the use of the Camp Ockanickon tract was obtained convinces us that the location at Lebanon is more characteristic of the territory to be served by our research. In the Lebanon State Forest, for example, there is a much higher proportion of pine than at Camp Ockanickon.

A combined laboratory and bachelor living quarters, a garage, a sewerage and water system, and a commercial electric connection were built at the new location on emergency funds.

The five-year-old permanent yield plots at Camp Ockanickon have been maintained; and the underplantings of conifers there will be re-examined periodically for some years to come. The small field house built over 6 years ago was retained. In 1934 the making of weather records at Camp Ockanickon, started 4 1/2 years earlier, was discontinued and new records were begun at the Lebanon Forest.

Emergency Funds

Since regular Station funds in 1933 were reduced about one-third, and have remained at that level, salary allotments from several emergency appropriations or assignment of paid personnel have, within the limitations earlier mentioned, been very helpful.

The erection of our own greenhouse on the campus of the University of Pennsylvania has not only helped to relieve the demands upon the University for space - hitherto generously met by the Botany Department only by crowding its own workers -, but has also proved a stimulus to fundamental research on the part of the Forest Service men.

At Philadelphia the temporary employment of up to nineteen men and women of the "white collar class" in 1933, and a smaller number in 1934, have helped to reduce the great gap between field (or laboratory) and office work which has existed both in the Forest Service and the B. P. I. branches here almost from the beginning. Unfortunately, much of the office assistance could be engaged for only a portion of each week or month.

Copeland Report

A large part of the task of canvassing the state forestry organizations for information on the status of forestry in our territory, and of reporting on its watersheds, fell upon this Station. The smallness of its staff necessitated the Director to do this work nearly single-handed. The report required his almost exclusive attention from August, 1932, to February, 1933. Mr. Schnur also contributed.

Tionesta Purchase

The very active interest of the Pennsylvania Forestry Association in the permanent preservation of the few remaining virgin timber stands in Pennsylvania, and several years' devoted effort by its extremely live committee in charge of this work, has crowned with success the Station's campaign to preserve a portion of the virgin forest on Tionesta Creek, within the Allegheny National Forest, for scientific research.

Because the idea underlying the acquisition of areas of virgin timber for scientific purposes has been misunderstood, even by many foresters, it is opportune to quote from the National Forest Reservation Commission's report for the year ending June 30, 1929, the following statement covering the purchase in 1928 of the 101 acres of such timber in Warren County, Pa., called "Heart's Content":

"Nothwithstanding the high commercial value of the heavy stand of white-pine timber, it is deemed eminently desirable that the Government should acquire this property, not as a museum site or as a recreational tract but as a laboratory for the promotion of silviculture within which to study both the physical and biological aspects of the changes which take place in such forests, the concomitant changes in the white pine-hemlock forest type, and the manner in which knowledge of these changes may be of value in guiding the development and management of the several hundred thousand acres of cut-over white-pine lands eventually to be acquired as the larger part of the Alleghany National Forest."

The Station had been active in promoting this purchase also.

The desirability of acquiring at least a portion of the Tionesta tract was first hinted at in this Station's 1929 report. An ecological examination in 1930 of 1200 acres on Tionesta, then about to be logged, convinced the Station of its priceless scientific value, but on account of the circumstances prevailing at that time, the purchase of only a few hundred acres was seriously advocated. This examination showed that the timber was principally beech and hemlock. Other species found were sugar maple, yellow birch, red maple, black birch, black cherry, ironwood, and striped maple. Except for some cutting by oil and gas companies for roads, pipe-lines and well-openings, and the culling of certain valuable species, notably black cherry, white oak and tulip poplar, where accessible to a plank road from Sheffield, most of the area had not been touched at all by man.

In the fall of 1932 a committee of the Pennsylvania Forestry Association, appointed for the purpose, visited the Tionesta tract, and later, at a meeting in Washington, D. C., discussed with members of the Forest Service, Biological Survey, Carnegie Institution, and American Forestry Association, ways and means by which all or a portion of the virgin timber then remaining and not readily accessible to the railroad already built, might be acquired by the Federal government. Because of the small sums available for national forest purchase, and the abundant offers of less expensive forest land, Chief Forester Stuart felt obliged to disapprove the purchase of any part.

The special committee of the Pennsylvania Forestry Association, however, remained undaunted, and late in 1933 appeared before the National Forest Reservation Commission in behalf of the purchase. This aroused sufficient interest to warrant a Forest Service appraisal of 500 acres, and a request upon the immediate owners for a price on two alternative tracts of this size. They were, however, found unwilling to consider any sale at all. After several months' delay the Association overcame the owners' unwillingness to sell, and convinced Chief Forester Silcox that with abundant new monies available for forest acquisition, appraisal of an area large enough to maintain both its botanical and zoological characters after the logging of the surrounding timber, was amply justified. An illustrated article by the Director on the value of virgin timber areas, and particularly the Tionesta tract, appeared in American Forests, and 1000 reprints were given wide distribution by the Pennsylvania Forestry Association. Finally, the Association's committee, together with Vice-chairman Rodney H. True of the Allegheny Forest Research Advisory Council, appeared before the National Forest Reservation Commission at its meeting on November 23, 1934, and obtained its approval of the purchase of 4300 acres on Tionesta Creek, of which about 3500 acres were virgin.

Lumber Code

A considerable part of the Director's time in 1933 and early in 1934 was taken up by work connected with the drafting, in collaboration with Regional Forester Evans and Director Behre of the Northeastern Station, among other foresters, of a suitable code of forest practices for the Northeast under Article X of the N.I.R.A. Lumber Code. He participated in most of the conferences between public agencies and the Northeastern Lumber Manufacturers Association, administrator of the Code for most of the Station territory.

Revisions of List of Forest Research Projects

A request was sent to all agencies presumed to be doing any forest research in our territory for an up-to-date description of their projects, in accordance with a standard outline. The response was excellent, but the pressure of other work has so far made compilation of the data impossible.

Cooperation and Public Relations

Cordial relations continue with the University of Pennsylvania, which furnishes us with office, laboratory, and greenhouse space, together with light, heat, and janitor service, entirely free of charge. Members of the Station staff have contributed substantially to the botanical seminars of the University, and a few members of the botany faculty have attended a series of our staff meetings. An opportunity for greatly increased contact with the University has been created by the bequest to that institution of the Morris Arboretum in Chestnut Hill, only half an hour's drive from the campus. The bequest included a very essential sum for the support of botanical research at this very promising arboretum of about 250 acres. Through other Forest Service units and the western forest schools the Station has contributed to its collection's planting stock of about 25 tree species, almost exclusively from the West. The University is particularly interested in obtaining stock from seeds of known source, and in this project there is every promise of our being able to assist them systematically. One of the Morris Fellows of the University spent the summer of 1934 at Camp Ockanickon on the work which will be the subject of his doctor's thesis and will be described later. Further evidence of the University's generous and cordial attitude towards the Station has been the signing of a supplementary agreement which placed at our disposal a greenhouse site adjacent to our basement laboratory in MacFarlane Hall. The Director contributed a lecture on forest influences to the Friday afternoon course at the University of Pennsylvania in 1934.

Cooperation with the Pennsylvania State College also has been particularly cordial. Doctor A. L. Patrick, head of the Soils Department, and Instructor W. U. Garstka of the Forestry Department, in 1932 made an intensive soil map of the 1250 acres along East Tionesta Creek previously covered by our survey of the forest vegetation, and in the following summer made a similar map of the Kane Experimental Forest. The College also arranged to analyse a number of soil samples collected from the sample plots in the Tionesta tract. All this work was done entirely without salary charges. In 1932 Research Professor A. C. McIntyre of the College and Associate Conservationist Schnur of our staff spent a week studying the effects of the 1930 drought on the forests in the neighborhood of State College, and will publish a joint paper on this subject. The same two men have maintained close touch with one another throughout their respective mensuration studies.

The Boyce Thompson Institute continued to furnish Mr. Hatch, free of charge, with unusual facilities for growing tree seedlings in aerated chambers, sterile except for introduced soil fungi, for several months in 1932.

Excellent relations were continued or established with several other educational institutions and organizations interested in our work. Among the visitors at the Camp Ockanickon Branch Station were members of the botany faculty of the University of Pennsylvania, and Mr. H. G. M. Jacobson and Dr. Herbert A. Lunt of the Connecticut Agricultural Experiment Station; Dr. R. F. Griggs, with a group of field botany students from the George Washington University, camped near the headquarters cabin for a few days in August, 1932, and intends to make this a regular stop on the botany department's annual field excursion to south Jersey. Professor H. J. Lutz of the Yale Forest School once again used our field house while engaged in work on the Plains of Southern New Jersey.

The Pennsylvania Forestry Association throughout its successful efforts in behalf of the Tionesta purchase has never failed to mention the Station as the source of its original interest, or to emphasize the scientific value of the virgin timber.

The Director and Mr. Hough in 1933 were chairmen of the nominations and type committees, respectively, of the Allegheny Section, Society of American Foresters. Mr. Schnur was one of four candidates for its executive committee.

The Station has been in contact with the National Forests and with the forestry departments of all four States in its Region, and occasionally also with such organizations as the State agricultural experiment stations. The Allegheny National Forest contributed very generously of CCC labor to improvements on the Kane Experimental Forest, within its borders, and the administrative men have been consulted in our plans for research on the area. We have offered suggestions for stand improvement work by the CCC on the National Forest. Dr. Jackson's damping-off experiments in the nurseries of the Delaware Forest Service, and Dr. Doak's work on mycorrhizal infections in the Maryland and Pennsylvania State forest nurseries, have contributed in no small measure to the most satisfactory relations with these bodies. As a unique form of co-operative effort worked out by Dr. Jackson may be mentioned his furnishing Nurseryman Oliver of the U. S. Forest Service nursery at Parsons, W. Va., with suitable receptacles for shipping to the Philadelphia laboratory specimens of seedlings infected by unfamiliar diseases. In several instances this method has enabled him to immediately wire back advice on control measures and thus to prevent some very severe losses of nursery stock.

In June, 1932, the Directors and a few staff members of the Central States and the Northeastern Stations, met with us at Kane in a brief but stimulating field conference. Messrs. Hough and Schnur visited the Appalachian Station's headquarters, and Schnur the Southern Station's Lake City (Fla.) branch in 1932. A number of men from other stations visited our headquarters or field stations.

Reduction of the Station's permanent staff of men trained for research from six to four, by Mr. Hatch's resignation and Mr. Morey's transfer to the Northeastern Station, has prevented any real expansion of our program of the five projects current when the preceding report was prepared. Only the extreme rarity of droughts as severe as that of 1930 caused the study of its very serious effects in Central Pennsylvania to be added temporarily as a sixth project.

The study of fire damage, except for the establishment of a few semi-permanent plots in 1930 burns in southern New Jersey, has had to be dropped. Even more unfortunately, since Mr. Hatch resigned on July 1, 1932, the cooperation of the Forest Service in the mycorrhiza project has been reduced to furnishing Dr. Doak with temporary laboratory assistance, the greenhouse facilities already mentioned, the truck especially designed for field work and the apparatus originally purchased for Mr. Hatch's use. The need to restore these projects to the Forest Service program is acute.

The number of articles completed by the Station for publication was smaller than planned for. Not only the reduced staff and the curtailment of regular funds are responsible for this, but also, paradoxically, the increase in emergency allotments. The assistants it was possible to hire with temporary monies were available only for uncertain periods and at uncertain times. The great majority of helpers were of course totally unfamiliar with our work, either in field or office, and under the circumstances were naturally of very variable quality. Their supervision required an inordinately large amount of time. The consequent interference with the consecutive and unhurried thought essential to grasping the significance of the complex data which most research projects yield, and to putting the derived conclusions on paper, greatly slowed down a perhaps rather over-ambitious manuscript production program.

On the other hand it is safe to say that the office work at the Station has more nearly caught up with the field work than at any time since 1929, and that the data already available have been put in such a shape that a fuller use can be made of them than ever before.

In the following pages a brief account is given of the work done in the three year period 1932-4 on the Station's six principal research projects.

Management, Allegheny Hardwoods. (Project M-1) (Forbes and Hough)

Little Arnot Plots

In 1928 four permanent sample plots were established in the Allegheny National Forest to compare three different methods of cutting. In the fall of 1932 Mr. Hough, with the aid of two field assistants, made a complete remeasurement of all reproduction on transects and quadrats, and all reserved trees on the plot. The trees which had grown into the 2" d.b.h. (diameter breast-high) class were tagged, mapped, and described. Photographs of the plots were made from all stations and all plot corners, transect corners, and the wooden pegs marking the spots from which photographs were taken, were replaced with iron pipes. Because the copper nails used originally in tagging trees had badly split the boles at breast height, they were removed and a paint spot was placed at the point of measurement. The trees were then tagged about 18" above the ground, using 1 1/2" brass escutcheon pins. On small trees the tags were fastened with copper wire loops. The crown maps were revised to show the changes in the canopy due to mortality or the entrance of new trees. During the winter following Mr. Hough, aided by one or two CWA workers, brought the field and office records of these measurements to the point of ready analysis. These data should yield some interesting evidence on the lengthening of crowns of residual trees by sprouting from epicormic buds on the bole; the survival of advance reproduction; mortality of reserved trees; sprouting; and other methods of importance to the silvicultural management of the type.

Heart's Content

Subsequent to the publication in 1929 of Lutz' detailed botanical description of this virgin area, counts of total age on several hundred stumps adjacent to Heart's Content were made by Messrs. Lutz and Morey in an effort to read the history of the virgin stands. A variety of circumstances, mostly beyond control, made the methods employed difficult and the results unsatisfactory. Through the generosity of Director Behre of the Northeastern Station, who allowed him official time for this purpose, Mr. Morey was able to complete two or three short papers dealing with different phases of the Heart's Content study. One of these papers, all of which were submitted for publication to "Ecology", compares the vegetation of Heart's Content and Cook Forest, both virgin white pine areas; the others discuss the age data for Heart's Content. This area has evidently had a rather complicated ecological history which is difficult to interpret from a limited amount of data.

Kane Experimental Forest

Inventory. Based on the boundary lines set out during the survey of the preceding year a ten-percent inventory cruise of the 1737 acres of the Experimental Forest was started in 1932 and completed on September 9. Seventeen hundred chains, or 21 1/4 miles, of strip were run to gridiron the tract at ten-chain intervals. Each chain length of strip was tallied separately and at the end of every fifth chain a stake was driven into the ground and a metal tag posted to locate the cruise line. The stakes, painted white, also served to mark the location of the permanent yield plots spaced 10 chains apart. A topographic base map, a prime requisite for planning future administrative or research projects, was one of the first fruits of this inventory cruise. The topography was mapped with 20-foot contour lines, and all culture and noticeable type or age class changes were plotted for a distance of 5 chains on either side

of each strip. Sample trees, bored for total age at intervals along the cruise strips, revealed that several different age classes of timber were represented. The inventory cruise sheets were compiled by age classes and conditions of stocking for the area as a whole. From these the species composition, basal area, volume, and size distribution were determined.

The purpose of making the inventory was two-fold. First, as an invaluable ecological record of the variations in composition to be expected within a relatively small area of second-growth Alleghany hardwoods. A comparison with the sample of this type of forest obtained over a much wider territory during the extensive surveys of 1929, and with the virgin timber-sample on East Tionesta Creek, is highly instructive. Secondly, the inventory was to facilitate the selection of areas for permanent sample plots, where either similarity or diversity of composition is to be sought; the latter function is an extremely important one in the setting up of a program of research in a type of forest composed of a large number of species combined in a great many different proportions.

In the same year a beginning was made with the laying out of a system of permanent yield plots designed eventually to cover the entire experimental forest. Fifteen 1/10-acre plots were established at 10-chain intervals on the easternmost cruise lines. This early establishment of plots, notwithstanding the fact that there was no authorized mensuration study of Alleghany hardwoods on the Station's project program, resulted from its recognition that a permanent plot in mixed stands, such as these, furthers ecological studies and is a valuable source of growth data. In accordance with this Mr. Schnur drew stem maps of all trees on these plots over 0.1" d.b.h.; he recorded diameters, obtained heights and increment cores from selected trees, and made photographs and descriptions of the plots. Some of these plots will also be used by Dr. Jackson for long-term studies of disease, particularly of rots.

To facilitate description of the locations of future work, the map of the experimental forest area was divided into 23 compartments which were marked or numbered so as to tie with the system followed in the making of the inventory cruise. Their corners are stakes on the boundary or along cruise lines. Compartment boundaries will be marked in the field and a set of records indicating the original conditions and the changes taking place in each compartment will be made later.

Additional permanent sample plots, aggregating 8 acres, were established in 1933. The location of each one of the new plots was carefully selected, following a very thorough study by Mossrs. Forbes, Hough, and Ackerman of the silvicultural needs of the entire 1737 acres, compartment by compartment, and after conferring with Supervisor Bishop and Mr. Vessey, superintendent of the stand improvement work on the Allegheny Forest under the CCC. It was the opinion of the administrative men that the silvicultural problem requiring an immediate study was the improvement of second-growth stands from which a paying quantity, that is, at least 10 cords per acre, of chemical wood might be removed. This excluded from experimentation stands less than 30 or 40 years old.

The first of two areas selected contained a considerable volume of hold-over beech, maple, and hemlock of very poor form, and second-growth black cherry so badly forked as to have extremely little promise. In addition to the defects mentioned, there was so much basal scarring by porcupines, and so much outright death from the 1930 drought, that the cutting in places had gone far beyond a thinning and become at least a first cut under a shelter-wood system. Well over 12 cords an acre were marked for cutting, and Mr. Ackerman later had no difficulty in persuading local people, even those living several miles from the tract, to fell and remove the wood for fuel. In the second tract, which contained very much less hold-over material, we had anticipated trying two grades of thinning: one based solely on the silvicultural requirements of the stand, and the other

on the economic requirements of a 10-cord yield per acre. The job was simplified by the discovery that the first degree of thinning would yield, on the average, 10 cords per acre.

It was a great blow to us when Mr. A. L. McComb, cultural foreman of a nearby CCC camp, whose services had been invaluable to us in the establishment of these plots, soon after beginning office analysis of the plot records, accepted a permanent research position in Iowa.

An interesting and useful type map of the Kane Forest was prepared from the data obtained in the 1932 cruise. All of the 1/10-acre plots tallied were shown to scale on the map, and the species composition, by percentage of basal area, of the stand was indicated graphically on each in color.

A 5-acre planting site was carved out of an 11-year-old second-growth stand, at very great expense in CCC labor. The job was undertaken in order that we might cooperate wholeheartedly in the Lake States Station's experiment with regional strains of Norway pine. At the last minute Mr. Bates found white grub injury in the Station nursery to have been so great as to prevent his shipping us stock from a representative series of seed sources until two years later. Norway pine is being used in large quantities in artificial forestation on the Allegheny Forest and throughout our territory, and although we have no formal planting project with this species, we consider the Lake States project to be of exceptional importance to us. Efforts are being made to keep the planting site in shape for at least two years by grubbing out all new sprout growth with CCC labor.

In the summer of 1934 five 1/2-acre plots in the Kane Experimental Forest were surrounded by rodent- or deer-proof fences, and portions of them by both. These will be used in studies of the part played in the forest by wild life. A drive on a nearby area, conducted with the aid of the CCC, revealed a deer population of 1 animal to every 13 acres. It was a great surprise to find that

northwestern Pennsylvania is menaced by the same multiplication of deer which has made further planting in central Pennsylvania impossible. An incalculable amount of damage has been done to the base of trees at Kane not only by porcupines but also by smaller rodents.

Weather observations. In 1932, prior to July 1, 3 weather stations were installed in the Kane Experimental Forest. One is located in the 5-acre plot cleared for a planting site, another in a stand of virgin beech and sugar maple, and the third beneath a 35-year-old stand of second-growth timber near the headquarters buildings. At all three of the stations records of maximum and minimum air temperatures and of precipitation have been kept since July 1, 1932. At station 3 the temperatures of the soil at depths of 6, 12, and 18" are recorded, while the hourly march of air temperature and humidity is registered on a hygrothermograph. On July 1, 1933 records of wind movement were begun, using anemometers exposed at 50' above ground on a steel tower erected at the open weather station and at 15 feet beneath the cover of the second growth. The instruments were read twice daily, morning and night, so as to record the usual day and night variation. Observing that a successor to the original good stand was either lacking or hopelessly stunted in certain cut-over areas along shallow stream courses, and finding no evidence of fire, we came to suspect the existence of frost pockets. The temperature record begun in the fall of 1933, at an additional station in one of these pockets, has already amply confirmed these suspicions and established lower minima and higher maxima along these streams than a short distance up the slope, where natural reproduction has been excellent.

Phenological observations. A complete record of the various stages of growth throughout the season has been kept for a number of tagged trees, shrubs, and herbaceous plants in the vicinity of each of the four weather stations ever since they were established. This record will be invaluable in correlating the effect of local climatic conditions on vegetation.

Black cherry germination studies. Black cherry, probably the most valuable of the Alleghany hardwoods, appears so abundantly on many cut-over areas as to present a problem regarding the source of the seed. As a result of earlier, desultory observations which aroused his interest, Mr. Hough started in 1932 a systematic study of storing black cherry seed over winter and the effects of various treatments on germination. From 500 seeds the pulp was removed while it was left on 1000 others. Five different storage treatments were used, ranging from a complete absence of cover to stratification between layers of burlap in sand, partly in the laboratory and partly under natural outdoor conditions. In the latter case the seeds were placed inside a box screened with wire mesh to keep out rodents and birds. The air and soil temperature readings required to correlate the effects of the different treatments on germination were obtained from the nearby weather station. A covering of leaf mulch with seed placed just beneath the mineral soil was found to give the best germination of seeds from which the pulp had been removed. Little or no germination was obtained from seed on which the pulp had been allowed to remain. These experiments are being continued.

Tionesta Forest

The 1929 extensive survey in the Alleghany hardwoods type throughout northern Pennsylvania yielded a large volume of data, not all of which unfortunately was sufficiently sound, statistically, to be used. In 1930 a fairly intensive study of about 1250 acres of the virgin forest of hemlock and hardwood on Tionesta Creek was made by a crew under Mr. Hough. The survey covered the lots which then seemed in most imminent danger of being cut, but because of lack of time did not include the very interesting area of white pine, much of it about 136 years old but some of it very much older, which has since been found to be a part of the tract. Our general knowledge of the tract was greatly extended when, subsequent to the establishment of a camp in

September 1932, Dr. A. L. Patrick and Professor W. U. Garstka of Pennsylvania State College made a systematic survey of the soil conditions from most of the area earlier studied by Mr. Hough. Many soil samples were collected, which, at a later date, were analyzed at State College without charge to the Station. The data gathered during the survey has since been laid down in a complete office report and used to prepare both a general and a soil map of the entire area. Subsequently these data have also served Mr. Hough and his CWA helpers in their efforts to establish the correlations which exist between the various soil types and the basal area, composition, and other characteristics of the stand in the area. During the same season the beginnings and the ends of all the 1930 transects were permanently marked, using 2" iron pipe, aluminum-painted, and metal witness signs. The location of each stake was indicated, moreover, by marks - so-called "butt-blazes" - on two nearby trees, and recorded thus in the field notes.

The camp also served Dr. R. B. Gordon of Ohio State University for a week as a base and center for collecting trips of herbarium material, for plant identifications, and the making of an ocular reconnaissance of the climatic climax forest covering areas not previously examined. A number of excellent photographs were obtained.

Finding that the Central Pennsylvania Lumber Company, which owned Tionesta, was about to peel bark over an extensive area of the virgin forest in the spring of 1933, we immediately undertook, and at short notice, to establish 6 or 8 permanent sample plots in the doomed area. In locating the plots not only the nature of the various stands was taken into account, but also their aspect, elevation, and slope. They were distributed amongst the following stands: pure hemlock, pure hardwoods, hemlock-hardwoods, pure pine - which had replaced a stand of virgin white pine blown down some 140 years ago - and old-growth white pine-hemlock-hardwoods. White pine occurs in only a few localities on Tionesta Creek, and unfortunately nowhere in the area permanently preserved. Messrs. Forbes and Hough spent several days selecting

these plots, while Mr. Schnur joined Messrs. Hough and Ackerman and a number of temporary men during the first work on the plots. The plan of work, matured over a period of several months, included mapping all of the trees before they were logged, and the making of a detailed description of their past history and then existing relationship to each other. The hemlocks were felled and bucked into logs that summer, permitting not only the analysis of their stumps but also of their stems. The merchantable hardwoods were not cut until several months later, during the winter, when most of the men were at Philadelphia on office work; consequently only stump analysis of these trees was possible.

Having obtained in advance the permission of the Central Pennsylvania Lumber Company to fell all trees which were below probable cutting limits, the crew cut discs, or cross sections of the stems at the stump, and preserved them for office analysis. Before the actual logging had begun, not only stem maps had been made of all trees down to 0.6" but also full descriptions of all physiographic or biotic features which might throw any light on the history of the stand. The problem of analyzing the small suppressed trees, mostly hardwoods of tolerant species, well over 5,200 in number, was solved to a large extent by preparing the sample discs taken from each specimen for examination by means of a grinding and buffing machine.

The main objective of this work, which under the circumstances was done under high pressure and as an emergency job, was to determine the history of these stands - when, why, and how each tree then present had entered it and how it had developed under its climatic and competitive conditions - as a guide to future silvicultural operations in second-growth forests.

As anticipated, the establishment of the sample plots--10 instead of the six or eight originally planned--took the time of Mr. Hough and four or more assistants for the entire field season, while it gave rise to an immense amount of office work to be done later.

Seed productivity, chestnut oak

In 1932 and '33 another cup count was made under two trees, identical in age and similar in size, which had been under observation since 1928. One of these trees in 1930 had produced 53 acorns, none in 1931 and '32. The other tree had produced 938 acorns in 1930, only 34 in 1931, and 556 in 1932. Although many other trees which had produced a good crop in 1930 bore no acorns at all in 1932, it was possible to collect about one bushel of chestnut oak acorns for planting. In 1933 the crop was about 1/5 as large as the 1930 bumper crop. A short paper, summarizing the findings in regard to the seed productivity of chestnut oak, was prepared and published in December, 1934. In the fall of 1933 about 350 new acorns were planted.

The crop of acorns of white and chestnut oak in the fall of 1934 was heavy, although the counts made under permanent sample trees of chestnut oak indicated that it was not quite so heavy as in 1930. Acorns of three different species, collected in October, were planted in rodent-proof beds at the Lebanon Station under various degrees and kinds of root competition. At Camp Ockanickon root competition had been found to be the factor above all others affecting the growth of seedlings. Soil and litter conditions also were varied.

Destruction of seed by insects and animals, chestnut oak.

In 1931 many chestnut oak acorns were collected which were split, probably by insects. Some of these were planted, but only 34% germinated in 1932. A number of acorns from which the radicle end, where the first rootlets appear, was bitten off were also planted to note the effect of this type of damage on germination. Only 18% of this group germinated in 1932. It has been observed that squirrels remove the radicle end of acorns apparently to prevent their germination when stored in winter caches. Several times small lots of acorns had been dug up and usually all of them showed this characteristic injury.

The seedlings remaining the beds planted in 1929 were examined in 1932. These seedlings had been planted under different litter conditions and at different depths. Most of them were still alive but many had been bitten off during the winter by rabbits. In the fall a 2-foot high 1" mesh wire fence was placed around these beds to prevent further damage.

A seed bed planted in 1931 with acorns treated with red lead and with "Crotox", a commercial repellent, but not screened, soon afterward showed evidence of the acorns being eaten by squirrels. Upon examination in the spring of 1932 all of these acorns had been destroyed.

Seed bed conditions and depth of sowing, chestnut oak.

Light. For the purpose of a preliminary experiment with light two beds had been planted in 1931. Although rodents had gotten through the screens in the preceding fall and destroyed all but a few of the seedlings, the beds were examined in 1932. Soil temperature readings at depths of 6 and 12 inches showed that the shaded beds had slightly lower temperatures than the unshaded. Light readings in foot-candles indicated that the lath screen reduced the light to about 40% of normal whereas in the case of the 1/2" mesh hardware cloth the light was still 80% of normal. All of our screened beds are growing under the 20% reduction.

Depth and manner of planting. Observations were continued on the three beds in which acorns had been planted in 1931 at a depth of 1, 2, and 3 inches respectively. The 1932 results of this sowing are shown in table 1.

Table 1

Depth of planting inches	Seedlings germinated		Seedlings alive 10/27/32	
	No.	Percent	No.	Percent
1	20	62.5	16	50.0
2	22	68.7	20	62.5
3	15	46.9	13	40.6

Mulches. In the fall of 1931 some beds were covered with a commercial mulch paper in order to study its effects in comparison with those of a natural leaf mulch. Germination in the following spring seemed to have been speeded up by it, but because it shed the water into the area surrounding the bed, the soil underneath became dry. Measurements of surface soil temperatures under a leaf mulch, under commercial mulch paper and on exposed surface soil, made in 1932, showed that the maximum temperature under the leaf mulch was always lower than in the other two cases. When the exposed soil surface was wet the temperature was lower than under the paper. However, as the exposed soil surface dried the daily maximum temperature rose, and during dry weather the temperature of the exposed sand was slightly higher than under the mulch paper. There were instances where the daily maximum temperature on the exposed sand was as much as 39° higher than on the surface under the leaf mulch. The difference between the temperature under the paper and on the exposed surface was never so great.

In the mulch tests of 1933 the soil temperature measurements were made not only at the soil surface but also at depths of 6 and 12 inches. The differences between the temperatures of the soil under the mulch paper covering and those with the soil surface exposed were surprisingly little. The soil temperature variations under the natural leaf mulch were found to be much less than in the other two cases.

Soil acidity. The germination in two seed beds treated with ground limestone in 1931, and also in the untreated control bed, was very good. By the fall of 1932 the seedlings in the two limed beds were, however, noticeably better in size and color than those in the unlimed bed. Lateral roots 3/4" or more in length were nearly twice as numerous on the seedlings in the heavily limed bed as on those in the untreated bed. The number of lateral roots on the seedlings in the light-limed bed was intermediate between that on the seedlings in the other two beds. Acidity determinations made during the summer of 1932 showed that at a depth of 6" the heavily-limed bed had a pH of 6.78, the light-limed bed of 5.17, and the unlimed bed of 3.55. No seedlings were removed during 1933 from the beds treated in 1931 with ground limestone. For all species combined, current growth during 1933 was slightly greater in the treated beds, but except for Spanish and white oaks the difference was not statistically significant. pH Determinations of the soil in these beds, made late in 1933, showed the effect of the limestone to be still pronounced.

In the fall of 1932 additional limed beds were sown with chestnut and white oak acorns. These beds were prepared in such a manner as to insure the limestone reaching greater depths. These additional beds made it possible to remove some seedlings annually while leaving an ample number for observation. Also these beds were trenched, to a depth of three to four feet, because it had been found that the roots of other vegetation invaded the limed areas. In 1933 some seedlings were removed from each of the beds planted in 1931 and the root systems compared. No great differences were found between those of the treated beds and those from the untreated. There was, however, a marked difference between the seedlings from the well-spaded control bed and those removed from an adjacent bed where the acorns had been planted without first removing the natural vegetation of ericaceous shrubs. The seedlings competing

with the underbrush were only about one-half as large as those from the beds from which all vegetation had been removed prior to the sowing of the acorns.

A statistical analysis was made of the height growth of all oak seedlings which originated from acorns planted in the fall of 1933. Since most of the growth at this time had come, of course, from the food stored in the acorn, it was not surprising to find no significant difference in growth between seedlings in the control beds and those in the beds treated in various ways.

Soil nutrients. Two beds treated with different amounts of muriate of potash, KCl, and a third bed, untreated, and held as a control, in 1931 had been planted with acorns of several species. It was believed that potash should result in the wood becoming harder during the growing season, thus preventing possible winter killing of the tops. No apparent difference in the seedlings appeared, however, during the 1932 growing season. For this reason additional beds were treated with potash, and sown with chestnut and white oak acorns. It was expected that these beds would provide more satisfactory material for study because the seed was of a higher quality than that used in 1931. At the same time other beds were treated with bone meal to increase the phosphorus content of the soil. To test possible deficiencies of calcium, potassium, and phosphorus in the soil, yet other beds were treated with dried poultry manure and combinations of manure, limestone, potash, and bone meal. Inspection during 1933 showed that height growth in the beds treated with potash was slightly better than in the untreated control beds, but not significantly so.

Soil moisture. During the summer of 1932 soil moisture was controlled on two chestnut oak seed beds by screening them with a "Celloglas" cover. This material is a commercial product made by dipping fly screens in a celloidin compound. It is translucent to the extent of admitting about 56 percent of the

light as measured at noon. Water was applied to one of these beds at the rate of 1" weekly from June 10 until November 5, 1932. The other bed received no water from May 27 until July 14, a period of 47 days, although seedlings began to wilt in it after 25 days. About two-thirds of the seedlings were dead when an inch of water was applied July 14. The leaf mulch was removed from one-half of each bed and the survival in the unwatered bed was noticeably better where the leaf mulch remained. Some of the seedlings in the watered bed had bright green leaves as late as November 23, 1932, or long after the leaves had fallen from all the seedling and mature chestnut oak in the vicinity. Soil moisture samples were collected from the Celloglas-screened beds at intervals during the summer. At the end of the first 47 days the soil moisture in the unwatered bed was only 1.66 percent of the dry weight, which is about the wilting point. Soil samples taken outside this bed and at definite intervals toward the center showed very clearly that there is a lateral movement of water in the soil; following heavy rains the soil moisture increased even under the screen.

Transpiration loss from these beds was measured with cobalt chloride paper. It was from 50 to several hundred percent faster from the watered bed than from the unwatered bed. Fruit jars were placed over some seedlings in the dry bed in an effort to check transpiration. This was apparently successful since the seedlings under the jars ceased to show the characteristic drought injury.

Transpiration by oak seedlings in the unlimed beds was found to be 50 to 100 percent faster than in the limed bed. No explanation can yet be offered for this; it might be due to a number of factors, such as size of leaves, number and size of stomatal openings, or soil moisture.

The size of stomatal openings was measured qualitatively by their absorption of chemicals. Xylol and benzene penetrate when even small openings

are present, absolute alcohol and benzine only when the openings are larger. Vaccinium leaves showed an absorption of all four chemicals. Oak leaves from the unwatered seed bed showed only a slight absorption of xylol, indicating small openings.

The interception of precipitation by the crowns of old trees may result in a deficiency of moisture in the seed bed under these trees. Early in May, 1932, four additional rain gauges were set up at Camp Ockanickon to study the extent to which precipitation is intercepted by different types of cover, viz., pitch pine; white and chestnut oak; pitch pine and oak; pitch pine, chestnut oak, and sour gum. In all cases the underbrush had previously been cut away and all the tree crowns were well above the gauges. A check gauge had already been established in the open. From May 6 until November 8, 1932, the precipitation was measured of 54 individual rains. The results from this experiment are indicative rather than final, because there are probably as many readings possible under each stand as there are locations for rain gauges. The intensity of the rain and the amount of wind accompanying it determined the rain caught in each gauge. Even when the deciduous trees were leafless there was still considerable variation in the amount of rain caught in the various gauges. In table 2 the results of the 54 measurements are shown:

Table 2

Type of cover above gauge	Total rain in gauge	Relation to gauge with no cover	Amount of average rain	Times each gauge caught most rain	Times each gauge caught no rain
	inches	per cent	inches	No.	No.
None	25.56	100.0	.472	34	0
Pitch pine	21.94	85.8	.406	5	4
Chestnut oak-white oak	22.23	86.9	.412	11	5
Pitch pine-white oak	22.91	89.6	.425	7	6
Chestnut oak, pine, gum	21.77	85.0	.404	4	5

An attempt was made to measure the rain in the gauges at intervals after rain had stopped falling. It was found however that drip from the trees was scarcely a measurable part of the total rain caught in the gauges under the trees.

These precipitation measurements were continued through the summer of 1933 and the winter of 1933-34. A paper summarizing these measurements is nearly completed. A statistical analysis of the data collected shows that there was a significant difference between the measurements made in the woods and those in the open, but there was also a significant difference among the four gauges in the woods, indicating that more gauges should have been used there.

Natural germination experiments. The single seedling remaining from the 1080 germinating acorns which had been staked in 1928 apparently died during the 1933 season. However it resprouted from the ground in 1934 although the total height of this sprout was less than the total height of the seedling in 1932. Thus after only six growing seasons almost the entire seedling stand that had originated after a heavy seed crop had disappeared. Rodents accounted for 86% of this loss, insects for 4%, and unfavorable seed bed conditions for the remainder.

The mean total height of the seedlings which had grown from acorns planted under natural conditions in 1929 was less in 1933 than in 1932. The current growth in 1933 was greater than that in 1932, but many of these seedlings had sprouted from the base rather than from the terminal bud so that there was a decrease instead of an increase in the total height. Some of the seedlings were excavated late in 1933 and all were found to have rather extensive root systems. The only abnormality noted was the loss of a portion of the tap root of two of them. This loss did not seem, however, to be linked with the dying back of the tops.

Dr. Jackson has been studying a root rot which apparently accounted for the early loss of tap roots in chestnut oak seedlings. Acorns were germinated in the greenhouse in soil from the Ockanickon Tract, and the emerging radicles examined periodically for root injury. Some damage, Dr. Jackson found, was caused by a small white grub, but he also succeeded in isolating a fungus from root lesions. Final evidence needed to prove that this fungus is the factor responsible for the root rot, would be successful inoculation of healthy seedlings with it; Jackson could not complete such inoculations, because of pressure of other work.

Summary of losses in planting. For all the seedlings in the various plots from acorns planted in screened beds in the fall of 1929 and for which the death rate in each successive year has been given in previous reports, a further loss of 7% of the original number planted was sustained in 1932-33. Since all the beds are protected from rodents, the very great loss to date must be largely attributed to unfavorable site conditions and to insects, although the latter alone caused but little damage.

Damping off experiments. Most of the acorns in a series of beds planted in 1932 were destroyed by mice. The beds were resown with pitch pine in the spring of 1933. At the suggestion of Dr. Jackson of the B.P.I. branch some of the beds were treated with formaldehyde prior to sowing. There was some damping-off in all beds but the loss was slightly less in the treated beds. Although quite a little is known about the action of damping-off fungi in prepared nursery soils, there seems to be a definite need for more information on the destructive effects of seedling diseases on natural reproduction. Some of the pitch pine seedlings were kept artificially dry during the summer of 1933. A few of them remained alive even after the soil moisture in the bed had fallen below the theoretical wilting point. The height growth of the surviving seedlings was, however, extremely small.

Transfer to Lebanon. In connection with the transfer of the south Jersey work from Camp Ockanickon to the Lebanon Forest, all of the oak seedlings which had been under observation at Ockanickon since 1928, and also those originating from the 1928-30-31 seed crops were excavated, measured, and weighed dry. The data on oaks have not as yet been analyzed, but a preliminary analysis of the data on pine indicates a surprisingly small, and even negative, response to a variety of organic and inorganic fertilizers.

Root studies, chestnut oak and pitch pine.

By far the most important work of the 1932 field season at Camp Ockanickon, requiring most of the time of three men for two months, was the excavation and the making of a photographic record of the complete root system of a 36-year-old seedling chestnut oak with a breast-high diameter of 1.4" and a height of 17 feet. Each root was removed with a stream of water, photographed in its entirety, and, after having been dried, weighed. Also the dry weight of the leaves and other aerial parts was obtained. The root system proved to constitute 45%, the stem and branches 51%, and the leaves 4% of the total dry weight. The root system covered an area more than 10 times that of the crown spread. Twenty-one percent of the leaves were planimetered for area. The total leaf area was computed from this. It was found to be twice the crown spread but only 1/5 of the spread of the roots.

While in 1932 the root system of a previously undisturbed tree had been studied, the next excavation, which took place in October, 1933, was that of a part of the root system of a chestnut oak converted six months earlier into a sprout by the cutting down of its original stem. Root systems may widely differ in shape, spread, thickness, absorptive qualities, and character, and cannot, therefore, be compared on the basis of dry weight. In this study the lengths of the roots were compared. The measurements were made from photo-

graphs taken at the time the root systems were excavated. Each root was photographed in its entirety, with the dead ends of each lateral clearly marked. Mr. Hazen measured the length of all branch roots and branchlets down to 1" in length on about 12 pairs of roots, one of each pair being from the seedling and the other from the sprout tree. Since we were particularly interested in the proportion of dead branch roots, only roots of similar length were compared. The comparison revealed more dead ends on the roots of the sprouting stump than there were on the roots of the seedling excavated in 1932, but the analysis of the data obtained is not yet far enough advanced to determine whether the conversion to sprout did actually increase the proportion of dead roots.

By a method learned at Nebraska from Professor Weaver, Mr. McQuilkin - a Morris Fellow in the botanical department of the University of Pennsylvania, temporarily employed as a field assistant at Camp Ockanickon - excavated without the use of water the root systems of a number of pitch pines varying in age and size from small seedlings to a tree 48 feet tall, 9 inches d.b.h., and about 85 years old. He supplemented these observations by some study of pitch pines on rocky ridges in the vicinity of Mont Alto, Pennsylvania, and some comparative observations of the roots of shortleaf pine in southern New Jersey. A preliminary paper prepared by him for our use indicates that the root system of pitch pine is to be classed in the generalized type. Mr. McQuilkin's summarized description follows: "It attains a moderately extensive development both vertically and horizontally. The basic plan consists of a tap root from which 15 to 30 horizontal branches originate and extend radially in the surface layers of soil. From these primary branches, horizontal and vertical secondary branches develop; these in turn give off tertiary branches, and so forth. Normally, the root system occupies a roughly circular area of top soil; in all

of this area except the marginal parts it has extensive contacts with the subsoil through the development of vertical, or sinker roots."

In addition to having given us an extremely workmanlike description of the root system of pitch pine as it develops from seedling to tree, Mr. McQuilkin has established that this species is capable of extensive root growth below the water table in saturated soils. To further quote him: "The descending branches of tap roots under water sometimes are arranged in a peculiar and characteristic fan-shaped mass, the explanation of which is obscure. Trees growing on saturated soils appear to be in full health and vigor." Mr. McQuilkin finds that "the root development of Pinus echinata in New Jersey is fundamentally similar to that of P. rigida. The most marked difference is the tendency of P. echinata to develop a much stronger and more massive tap root, with which is coordinated a weaker development of secondary supporting roots. This species does not invade areas where the water table is high." Of mycorcorhizae he says: "These are a conspicuous feature of pitch pine roots. Their period of growth coincides with that of non-mycorrhized tips. They are found at all depths in both drained and saturated soils, but attain their greatest profusion in the surface organic layers."

Behavior of chestnut oak sprouts. The root study of chestnut oak, in which a comparison was begun of the root systems of an undisturbed tree and of a tree converted into a sprout, was undertaken as a first step in a much more comprehensive study of the whole phenomenon of sprouting. Another exploratory investigation of sprout behavior dates from 1930, when three 1-acre plots were laid out in an 8-year old stand of sprout oak and pine. One plot was clear cut. The second was only partially cut, in the following manner; in each sprout clump only one and sometimes two of the best stems were left, and some of the inferior species such as gum and post oak were clear cut. In the third, the check plot, no cutting was done but the best one or two sprouts in each clump were numbered

and measured. On both treated plots resprouting followed the cutting and during the winter of 1933-34 some of these sprouts were cut back by a CWA crew. During the 1934 field season a transect was run across both of the cut plots to get some measure of the relative sprouting vigor following the two methods of cutting. Preliminary examination of the data showed that both the number and size of the sprouts on the clear-cut acre were much greater than on the thinned plots.

Mensuration, baks (Project ME-1)(Schnur)

In 1923 a project had been started by the Appalachian Station to establish complete yield tables for the upland oaks and associated species in its region. These tables were to show the volume of wood produced per acre in terms of cubic or board feet for any combination of site quality and age. Because of their general and very important application to forestry work itself, and their being essential in any effort to persuade land owners and farmers to protect and perpetuate their forest land, or to give them an insight into the relative productivity of land for the raising of wood and of ordinary farm crops, and because the upland oak types extend throughout the eastern United States, the preparation of these tables in 1928 had been made a joint project of the Allegheny, Appalachian, and Central States Forest Experiment Stations.

The close association of many other hardwoods and often certain kinds of softwoods with the oaks made the construction of volume tables for practically all of these associated species almost unavoidable. Since a merging of northern hardwoods with the oaks occurs in this region, the Station's contributions to the volume tables include data for hard and soft maple, beech, and black cherry.

Incidental to the collection of some of these data studies were started in 1928 to determine the solid wood contents in cubic feet of stacked cordwood obtained from trees of different diameters, a study which is of particular interest to the chemical and pulpwood industries and was carried out largely

in cooperation with the Allegheny National Forest and the Day Chemical Company of Westline, Pennsylvania. The results of the cordwood converting factor study were published in the November, 1932, issue of the Journal of Forestry in an article entitled, "Converting Factors for Some Stacked Cords". On an area in the beech-birch-maple type in Pennsylvania the amount of solid wood per stacked cord was found to be approximately the same for trees of all diameters when random piling was used and all sticks over 8" were split.

In 1932, when the oak yield project was left without a leader by the resignation of Director E. F. McCarthy of the Central States Station, the Allegheny Station took over the leadership. In the almost ten years that this study had been under way, volume measurements had been obtained and tables prepared for 5 different kinds of oaks and 8 associated species. Temporary yield plots had been established throughout the eastern upland oak region. At the time of the change in leadership the measurements on all of these plots had been assembled and the volumes had been computed for each plot by species, crown class, and diameter group, so that the material was all ready for statistical analysis and yield table construction.

The analysis of this material covered a tremendous amount of data. There were 418 temporary sample plots upon which 9 distinct species of oaks, 2 miscellaneous oak groups, and 33 other species had been found. Assembled by diameter, crown class, species, and plots, individual tree measurements fell into more than 17,000 groups. Mr. Schnur, who was in charge of this project for the Station, extended his detail to Washington until the tables and the accompanying manuscript were completed. During July and August, 1932, these data were punched on cards, in preparation for the sorting and tabulating which was to be done automatically by means of Hollerith machines. During the ensuing fall the cards were sorted 15 times, and 15 different tabulations were made. From these tabulations the following "average" curves were plotted:

Height of dominant trees in relation to age.

Total basal area in relation to age.

Average basal area in relation to age.

Number of trees in relation to age.

Volume in cubic feet in relation to age.

The above average curves were the basic curves for the yield tables.

Since oak stands are composed of such a variety and assortment of species, it was necessary, before the computation of the yield tables themselves could be undertaken, to make a study of stand composition. The question which arose was: How does the composition of a stand affect its volume, diameter distribution, and other characteristics? Analysis of a random sample of 20 out of the 400 acceptable plots indicated that stands may be broken up into the following 4 main species groups:

1. White oaks
2. Black oaks
3. Other tolerant species
4. Other intolerant species

Statistical analysis showed these groups to differ significantly one from another in their effect on the stand. The analysis was made with these 4 groups as a basis. The yield and stand tables for the upland oak type, the result of data collected on 418 plots scattered over 13 different States, were completed during the year 1934.

In their compilation several departures from the customary yield table procedure and hence the development of some new methods were found necessary. These were made possible by the many helpful ideas and suggestions which Mr. Schnur obtained from Mr. Schumacher and others during his detail in the Office of Forest Measurements. Illustrative of some of the new procedures, necessarily of a technical nature, are the following:

Because anamorphosis could not be used, a relatively simple method was developed for site classification, using standard units of dispersion. The basal area analysis caused considerable trouble but was finally handled by graphic adjustment of a percentage alinement chart. Density was found to be an important source of variation even though only fully-stocked plots had been selected in the field. The logarithmic straight line relation between number of trees and average diameter, adopted by Reineke in his article on stand density index, was used in a modified form as a basis for rigidly determining density. As used in the oak study, then, density was the percentage relation between actual and average number of trees as computed from this straight line. A multiple curvilinear correlation between cubic volume, age, site, and density was computed to find out how much improvement could be made by including density. The "standard error of estimate" was lowered 30 percent and the correlation was increased significantly.

The analysis of diameter distributions, based, as already mentioned, on 4 species groups, revealed the existence of a definite relation between the oak groups and the quality of the site. The percentage of white oaks decreased as the site quality increased while the percentage of black oaks increased. The correlation between these two groups is negative and very high. No statistically significant correlation was found with age. This finding simplifies future estimates. If a species group makes up 25 percent of a stand at 10 years of age it will make up the same percentage at any future age provided the stand remains in its natural state. Using Pearson's Type III frequency curve, which is very easy to apply because of available tables and seems to fit timber stands reasonably well, a series of synthetic stand tables were built up for these 4 species groups.

Upon his return to Philadelphia, after having spent 22 months in the Office of Measurements in Washington, Mr. Schnur prepared a manuscript entitled "Yield Stand and Volume Tables for Even-Aged Oak Forests". This manuscript has since been submitted for publication as a Departmental technical bulletin.

Considerable progress was made also on tree volume comparisons between different species from the same area and between the same species from different areas. All volume equations were completed but only half of the 44 comparisons were actually made. The indications are that trees of different species but identical diameter and height on the same area do not vary significantly in volume. This points to the possibility of using one volume table for several species.

In 1934, at the end of the first 5-year period, the permanent yield plots at Camp Ockanickon were remeasured. Some of the 14 plots were located on a "safety strip", from which all dead trees had been removed and the brush mowed, piled, and burned. Growth on this strip appeared to have been less than on adjacent strips, where the trees had continued to grow in competition with heavy underbrush. Whether this effect was due to injury by the fire when the brush piles were burned, or due to desiccation resulting from the removal of the low vegetation, is as yet uncertain.

Mensuration, Coastal Plain forests (Project ME-2)(Schnur)

The diameter distribution study of loblolly pine in the sample plots on the Eastern Shore of Maryland and in Delaware, mentioned in our previous reports, was completed and demonstrated the merits of an improved method of preparing stand tables. It was found that a Pearson Type I frequency curve fits the data almost perfectly. From this curve a probability chart was prepared which showed for stands of various diameters the percentage of trees that may be expected to occur above or below any diameter. A manuscript, entitled "Diameter Distributions for Old-Field Loblolly Pine", describing the methods of analysis used in this study, and prepared by Mr. Schnur who is in charge of the Station's mensuration work, was published in the October 15, 1934, number of the Journal of Agricultural Research.

Average curves were plotted, which showed not only the relations existing between the number of trees and the average stand diameter but also between this number and the age of a stand. From these curves and a probability chart - often called "stand chart" - a table was prepared which gave the number of trees in each diameter class for stands of various ages and of different mean stand diameters. These distributions, although of course representing average conditions only in the untouched old-field stands of loblolly pine in Maryland, furnish a definite knowledge of average stand conditions which may well serve woodland owners and foresters as a guide in their silvicultural work.

Volume tables for loblolly pine were made from measurements supplied by the Maryland State Department of Forestry and photostatic copies handed to local foresters. The amount of merchantable timber for trees down to 3-inch tops (diameter outside the bark) was given in cubic feet and for those down to 5-inch tops (inside the bark) in International board feet. These tables, together with an earlier one giving total volume were used in the sample plot analyses.

Since mortality is a very important factor in growth predictions and the records of these permanent sample plots are the only source available so far for loblolly pine, an intensive study of the mortality rate was started in 1932.

More than 30,000 individual tree records in the loblolly pine plots were tabulated and subsequently punched on cards by the Washington office. One-third of the immense job of tabulating this material, which otherwise would have had to be delayed at least a year, was done by eight CWA girls working on it for two months. Before that Miss Loose and Mrs. Evans of our office in Philadelphia had already spent 15 months on this tabulation. All this labor, however, will have been amply repaid when, as is expected, answers are obtained to a number of questions such as the following: (1) How do old-field loblolly stands of varying density develop naturally from saplings to maturity? (2) What effect does thinning have on stand development? (3) How does mortality affect

development of the stand? (4) Are individual tree records necessary or justifiable in studies of this and other kinds?

These permanent plot records, among the oldest in America, were heavily drawn upon by Reineke in studies of stand density index, by Dwight in Canada in growth studies, and by Schumacher and Chapman in growth prediction investigations for the Forest Survey. Undoubtedly many of the basic data will be included in our future publications as an aid to American mensuration.

The punch-carding of the records was completed by the Washington Office during 1934. Five sortings and 22 different summations were made on automatic sorting machines for an analysis of thinnings. The analysis on the basis of basal area was completed and embodied by Mr. Simmons in his first draft of a paper on the effect of thinning loblolly pine. Although 5 remeasurements of these plots provided unique data, only a few of the plots had been thinned, and without much variation in intensity. The relation, as expressed by a line of regression between basal area and future growth, was found to be very similar for thinned stands and for natural stands of varying degrees of density. Since a greater range in density was available in natural than in thinned stands, all plots were thrown together for a correlation of growth with density and basal area. It was found that both mortality and growth can be predicted with a fair degree of accuracy from either density or basal area.

Forestation, Planting (Project Fp)(Wood)

This project of finding ways and means to increase the productivity of the inferior sprout hardwood stands of the New Jersey Coastal Plain was inaugurated in 1930. Repeated fires and cuttings have reduced the forests of the New Jersey Coastal Plain to poorly-stocked stands of pitch and shortleaf pines and hardwood coppice. It has been the policy of the New Jersey Department of Conservation and Development where such stands occur in its State

Forests, to cut the hardwoods clear when they reach fuelwood size, leaving the pine which is unmerchantable as cordwood, and to plant coniferous seedlings among the stumps. Later when the hardwood sprouts begin to compete seriously with the planted seedlings, they are cut back and the conifers are allowed to mature. In spite of the rather large scale on which it has done this work, the Department has been unable to make any systematic check of the results achieved.

Such a silvicultural system cannot be successful unless the planted conifers are given a chance not only to survive but also to develop in competition with the natural vegetation. In order to study the behavior of seedlings set out under these conditions, the Allegheny Station, each year from 1931 to 1933 inclusive, planted several thousand pine seedlings of various species in the open areas of the old cut-over and burned hardwood lands around Camp Ockanickon, New Jersey. In addition a 1/2-acre plot, cleared the preceding year of all brush, in 1932 was protected against rabbits by erecting a 2-foot high, 1-inch mesh wire fence around it, and then planted with seedlings of white, red, and loblolly pine, spaced 6 x 6 feet.

The Ockanickon Tract is situated just within the western edge of the well-known New Jersey "Pine Barrens". Although its soils are somewhat better than those of this region as a whole, they are nevertheless sandy and consequently well to excessively drained. The plantations had to endure some extremes in weather, including a minimum temperature of -25°F. in 1933. The driest year on record, 1930, and the wettest month on record, August, 1933, occurred since the first plantings.

By periodical inspections and measurements of the planting in the fall of each year - except in 1933, when lack of temporary help compelled postponement of the measurements until May, 1934 - the individual history was obtained of 10,711 pine seedlings planted during the four years mentioned.

The following tabulation, Table 3, summarizes the percentages of survival from each year:

Table 3

Percentage of Survival of All Species of Seedlings Planted in each Successive Year since 1930.

When planted: Year	Species and class: Name		Total planted: Number	Survival at end of: First year: Per cent (1930)	Second year: Per cent (1931)	Third year: Per cent (1932)	Fourth year: Per cent (1933)	Fifth year: Per cent (1934)
	White	2-1	495	79.6	54.9	39.4	38.6	38.6
	Red	2-1	514	88.4	82.5	81.2	79.9	79.4
1930	Jack	2-0	795	58.4	43.0	34.3	34.0	33.6
	Shortleaf	2-0	1,000	42.2	36.6	35.8	31.2	30.8
	Pitch	2-0	605	70.7	69.5	68.2	59.2	58.5
	All Species		3,409	63.5	53.5	48.6	44.9	44.5
				(1931)	(1932)	(1933)	(1934)	-
	Red	2-1	1,010	66.5	42.2	36.8	36.5	-
	Loblolly	2-0	424	51.7	43.2	40.3	37.5	-
1931	Loblolly	1-0	1,006	87.7	83.5	72.4	71.0	-
	Shortleaf	2-0	348	69.5	62.7	61.8	59.8	-
	Pitch	2-0	554	70.4	68.4	54.4	54.2	-
	All Species		3,342	72.0	61.4	53.2	52.4	-
				(1932)	(1933)	(1934)	-	-
	White	3-0	282	87.2	86.2	85.1	-	-
1932	Red	2-0	412	47.8	24.0	21.9	-	-
	Loblolly	1-0	742	76.0	66.6	57.6	-	-
	All Species		1,436	70.0	58.3	53.3	-	-
				(1933)	(1934)	-	-	-
	Virginia	2-0	1,333	99.9	99.2	-	-	-
1933	Shortleaf	2-0	534	84.5	84.5	-	-	-
	All Species		1,867	95.4	94.9	-	-	-

In the winter of 1933-34 CWA workers cut back the hardwood sprouts which threatened to overwhelm most of the planted pines that had survived.

The first draft of a report on this planting project, in which the influences of all the various factors of survival and growth, such as average climate, climatic variations, conditions of planting stock, animals, insects, diseases, vegetative competition, are analysed from the data collected from Camp Ockanickon during the preceding 5-year period, was completed towards the end of 1934.

Protection, Fire (Wood)

In the summer of 1932 the 11 fire-damage plots, established in southern New Jersey a few weeks after the severe fires of 1930, were re-examined. Five of these plots were located on the Camp Ockanickon Tract, 2 on the Lebanon State Forest, and 4 on the Bass River State Forest. One of the 11 plots was an unburned check plot. The examination revealed that there had been only a slight increase in mortality since the previous examinations, of which the results were given in our 1931 report. A few of the trees which had first started to sprout feebly at the base or in the tops, had subsequently died, but in most of the plots the basal sprouts had grown to heights of 10 to 15'. The bark had already fallen from most of the dead trees so that the painted identification numbers were lost. On some of the plots many of the trees were already down.

Types

Mr. Hough's article on diameter distributions, dealing particularly with the white pine type, was published under the title "Some Diameter Distributions in Forest Stands of Northwestern Pennsylvania" in the Journal of Forestry, for December, 1932.

The almost complete breakdown in the Director's personal research work as a result of the Copeland report made it impossible for him to complete the

analysis of the 1929 survey data for the Allegheny hardwoods type.

The efforts of the type committee of the Allegheny Section of the Society of American Foresters, which has been headed for more than two years now by Mr. Hough of our Station, have been directed toward adapting the general type classification proposed by the parent society late in 1931 to the needs of the Allegheny territory. A questionnaire, sent in January 1934 to members of the committee, showed that the great majority was in doubt as to the applicability of the parent society's detailed classification and favored a broader and more general classification. Such a classification was made up by grouping together various subdivisions of the detailed classification; this procedure had been suggested in the parent society's report. The revised and simplified classification was accepted by all of the members of the committee and will be sent in mimeographed form to the Section's entire membership for comment or approval. A new type map of the Section's entire territory, to be made from existing type map data for Pennsylvania and other data furnished by the members of this type committee for West Virginia and Virginia, is being prepared to accompany the new proposed classification.

Special, 1930 Drought (Schnur)

During the summer of 1932 Mr. Schnur and Professor A. C. McIntyre of Pennsylvania State College spent a week obtaining data on forest mortality in several areas of central Pennsylvania that had been badly affected by the 1930 drought. Strip cruises of these areas were made, and records kept of the diameter, height, crown class, and vigor, by species, both of living trees and those which the evidence showed had been killed by the drought. On each strip a number of increment cores were taken, and were later analysed by Professor McIntyre. Due to Mr. Schnur's already overcrowded schedule and his work on the Copeland report, it was 1934 before the statistical analysis

of the data collected could be completed. Examination of both the basal area of the main stand and of the number of young trees on 23 plots, distributed among 7 areas, showed that particularly the coniferous species had suffered severely from this drought.

A joint manuscript giving the results of the drought study, for publication as a Pennsylvania State Agricultural Experiment Station bulletin, was completed by Messrs. Schnur and McIntyre in 1934.

RESEARCH IN FOREST PATHOLOGY

Mycorrhizae (B.P.I. Project 6P)(Dr. K. D. Doak)

Preliminary Work

Surveys were made during the three years to obtain a culture collection of authentic soil fungus species and information on mycorrhiza under field conditions. This material furnished the basis for all of the experimental work undertaken during and since that time. In addition to the culture collection of authentic species, a number of the groups of direct isolations have yielded fungi of interest in various respects in connection with the mycorrhiza habit of some species of trees. Synthesis of mycorrhiza in pure culture has been carried out as rapidly as the hosts could be grown under sterile conditions. Synthesis of mycorrhizae with known fungi was attempted for each host as new fungi were cultured. Experimental work with the same fungi was done preliminary to growth studies on a larger scale. Some of these growth relationships have already been determined for restricted artificial conditions. New attempts at isolation of fungi not cultured successfully at first from sporophores have been made during each successive year, mainly in connection with the collection of other material, and it is expected that species already in the collection will furnish sufficient material for any extensive experimental work in the future. Many new methods for isolating fungi were developed and physiological studies made in the course of this work.

Mycorrhizal Habit Among Alleghony Forest Tree Species.

The development of mycorrhizae on root systems was found on every important native and exotic species of tree and under all conditions where collections were made. The significance of this ability to form mycorrhizal unions with the roots was determined by making collections from the same species growing in different sites and localities.

By microscopical examination of very thin cross-sections, a histological study was made of the various types of roots on a tree that are related to mycorrhiza formation. Thus it was possible to determine the nature and extent of the mycorrhizal habit for the more important native and exotic species. The work has resulted in the establishment of important points which serve as the basis for future studies. Assistance obtained through cooperation with the Alleghony Forest Experiment Station by part-time student aid has made possible the completion of many phases of this work. The results of this study, wherever they revealed facts holding good for a number of tree species in a genus or for an entire genus, have been published. (See publication by Hatch and Doak, 1933).

Isolation and Uses of Known Species of Fungi.

In the course of this project, 118 species of soil fungi have been obtained in culture. All of these, derived from the groups Hymenomycetes and Gasteromycetes, were obtained by making tissue cultures from the sporophores on artificial media. Only soil-inhabiting forms were used, but a few which are found occasionally on wood were held in culture because of their likely soil connections. Pure culture experiments with 42 combinations of hosts and fungi have given proof of the mycorrhizal habit of these soil fungi. Notwithstanding the absence of any associated organisms, the inoculation with a single kind of fungus caused mycorrhiza on certain coniferous trees. Various members of the genus Boletus have given mycorrhizae

with many native conifers under these conditions. Many Agaricaceae or gill fungi obtained in culture appear to be equally important to trees because of their mycorrhiza-forming ability; a few cases of a similar influence by Gasteromycetes have been found. The occurrence of certain fungi within a given region has been studied as to their production of sporophores, but the evidence is not conclusive to indicate whether or not either of these groups is more important than the other.

Nursery Inoculation.

After several fungi had been proven to possess the mycorrhizal capacity in pure culture, inoculations were attempted in two of the State nurseries of the Allegheny Region, at College Park, Maryland, and Mont Alto, Pennsylvania. They were made early in the first year's growth of white pine in each case, followed by sampling of root systems developed in the vicinity of the inoculation points. The same was done during the second growing season and at the same time attempts were made to reisolate the fungi. None of the mycorrhizae formed in and near these points of inoculation were distinguishable from those formed in the uninoculated parts of the same and adjoining beds; likewise the reisolation attempts were negative. From these inoculations it appears that establishment of a fungus from cultures requires the elimination of all other interfering organisms from the soil by some form of complete sterilization. This would not be a practice applicable to nurseries unless certain to possess other advantages. Not until the differences in the effects of these fungi on the hosts, and also the exact nature of these differences shall be known, such operations for nurseries will remain impracticable. None of the fungi found forming mycorrhizae on nursery stock appear to be injurious, but the nature of the association in many cases has to be determined yet before the degree of their usefulness or harm will be known.

Secondary Parasitism of Mycorrhizae.

Tested with the two parasitic Rhizopogons, R. parasiticus and R. roseolus, the mycorrhizae produced on Pinus strobus, P. echinata, and P. resinosa were attacked. Both of these parasites attack the mycorrhizae produced by Amanita muscaria and A. rubescens. This furnished final proof that their parasitism was not confined to species of Boletus and Boletinus.

Culture Methods.

Among the useful methods for handling the hosts and fungi for trial of the mycorrhizal reaction, several simple flask methods were developed. These, for the most part, were modifications of some of the methods used in the past by other investigators. It was found useful to combine the method of Melin (1925) with the tube-addition method developed by the writer in earlier work. The sizes of the flasks used as culture chambers were selected to conform to the size of the various hosts with which the fungi were to be tested. Only in the case of species grown for periods exceeding a year with Hymenomycetes or Gasteromycetes were other culture methods necessary. During the time that Dr. P. L. Fisher was connected with the work, a drip culture method was given trial for use with fungi inoculated directly into the sand. To date this has not given positive results with any of the fungi other than Boletus granulatus. The Gasteromycetes, Lycoperdon gemmatum, L. pulcherimum, Scleroderma vulgare, and Ithyphallus Ravenelii grew well in such cultures but did not form mycorrhizae.

Relation of Mycorrhizae and Pseudomycorrhizae to Coniferous Species in Nurseries.

During 1934 collections were made of one-year-old seedlings, grown during the season of 1933 and removed from the nursery in early spring 1934, for the purpose of determining the amount of mycorrhizae and pseudomycorrhizae developed on root systems, and the relation of this to the size of the root

systems under different nursery conditions. The purpose of such a study included also a treatment of the amount of short root development and the length of extending or "mother roots" for individual seedlings. All of the nurseries in the Alleghony region were represented in this study.

Pseudomycorrhizae were more prevalent in poorly aerated soils or under conditions where the development of cork at the points of emergence of lateral mother roots was most prevalent. Few short roots under conditions of high moisture were mycorrhizal. Mother root tips becoming mycorrhizal were found primarily in dry soils where root growth had been retarded during the season. Tips of tap roots were never found mycorrhizal, yet, laterals developed from the lower ends of tap roots during the first season often became mycorrhizal later. Those were then found to possess typical short root structures instead of a mother root structure such as is usual for all branches from the tap root. Upper portions of the tap root gave rise to pseudomycorrhizae whenever short roots were developed there, but it was in this location that short roots with root hairs were frequently found.

Seed Germination and Pure Culture Trials.

Coniferous seeds are easily made culturally sterile because of the hard, impermeable seed coat which permits long exposure to mercuric chloride. Three species of oaks were obtained in pure culture by picking the seed directly from the trees, removing the outer seed coat, and sterilizing the surface of the cotyledons with calcium hypochlorite. Few losses due to injury of the embryo were caused by this method. Seed of tulip poplar was successfully sterilized by the same method. With maple (Acer saccharum) and ash (Fraxinus americana) the method was only partially successful. All of the seedlings grown from sterilized seed were used for inoculation with the fungi tested previously with coniferous species. One case of mycorrhizal

development was found with an unknown sterile mycelium fungus isolated from the roots of tulip poplar and found mycorrhizal with the same species. The fungus has been tentatively identified by Burgeff's system as Mycelium radicis Tulipifera. The results of a morphological comparison between the form occurring in Nature and that produced in culture is recorded in a publication by Cohen and Doak, 1935 (listed under publications).

Growth of Seedlings and Fungi in Non-sterile Cultures.

Drip cultures with 11 fungi were carried on for 8 months before any seedlings were removed. Three species were handled in part by this method. The series included also one control culture. Root development of two species (Pinus taeda and P. rigida) was inferior to that found in aerated cultures. One fungus, Boletus granulatus, was used with positive results. In 3 others, those inoculated with Lycoperdon gemmatum, Tricholoma personatum, and Boletus bicolor, the results were negative. The first two of the latter have proven negative in pure culture but the last caused mycorrhiza with both species of pine under the same condition. It was found that a few fungi grew well under drip culture conditions, and re-isolation was impossible. The fungi appeared to grow even more profusely along the root surfaces in these cultures than in cultures from which all free nutrient had been removed, but mycorrhizae were lacking in most of them and in all of them, even where formed, below one-half-inch from the surface of the sand. Most of the short roots showed occasional root hairs, but the development was much less than in the aerated cultures.

Direct Isolation from Roots.

By the use of surface sterilization methods it was found possible to obtain several species of mycorrhizal fungi in culture from roots. All of

these had to be identified by comparing their growth characters with authentic mycelial cultures made from sporophores. Of the many types described in the literature, none are found as widely distributed as the forms occurring on Fagus and Quercus, every member of which genera lack the association found common among the other deciduous species. The establishment of these various types gave rise to the manuscript published by Hatch and Doak in 1934. Root anatomy as it relates to the mycorrhizal fungi present has been taken into account and no exceptions found in the genus since that time. Relations between forms of mycorrhizae on other genera of Coniferae and the causal fungi have been established, with the result that anatomical differences and the limitations in distribution of these fungi have been established.

One fungus, isolated from roots of Pinus taeda, resembled Rhizoctonia silvestris Melin. It formed not only the mantle and Hartig network characteristic of ectotrophic mycorrhizae on P. taeda, P. resinosa, P. strobus, P. rigida, and P. radiata, but also infected the cortex of mother roots. Although the latter type of infection was extensive, roots of P. taeda had not been killed after eighteen months in culture.

Growth Relations.

Since the mycorrhiza project was inaugurated, several preliminary experiments have been conducted to determine the effects on growth of coniferous seedling trees under controlled conditions. The results obtained under some of these were conclusive, but the exact application of the growth differences to forest soils could not be made because of the fact that a complete absence of mycorrhiza has never been found in nature. No real comparison has ever been made, therefore, between a mycorrhizal and a non-mycorrhizal root system. All the methods possible for eliminating the

mycorrhizal fungi from soils cause changes so great chemically that interpretation of the growth differences was impossible.

In pure culture nitrogen nutrition has been found influenced most by the development of mycorrhizae on a root system. Two preliminary growth series with Boletinus pictis and Pinus rigida in pure culture have demonstrated that nitrogen starvation, produced by supplying only peptone as a source, was greatly reduced by the presence of the fungus, and an increase in growth took place. Mycorrhiza-formation was more abundant on plants having no mineral nitrogen source than where both nitrate and ammonium were supplied. Effects on the fungus were not evident with excess mineral nitrogen. These relations, which were sufficiently distinct for both series, indicated that the mycorrhizal habit reaches its highest development under conditions of mineral nitrogen deficiency.

Nitrogen excesses and deficiencies, in the form of ammonium, nitrate and peptone, did not prevent formation of coniferous ectotrophic mycorrhizae with fungi known to produce them under pure culture conditions. These nutrient conditions changed top and root growth and the root/top ratio.

Phosphorus and potassium excesses and deficiencies did not have measurable influences on mycorrhiza formation, but calcium in excess caused reduction in the number of cortical layers passed between by the hyphae, and calcium deficiency increased penetration as far as the endodermis in white pine and pitch pine with fungi known to pass between two cortical layers under balanced nutrient conditions.

Through the use of dyes, light green and methylene blue, and living mycorrhizal and non-mycorrhizal root systems, it was found that absorption of water occurs more slowly through mycorrhizal than non-mycorrhizal short roots. Structurally different cells -"passage cells" - furnish a path of

absorption after thickening of the endodermis. This condition exists in both short roots and extending roots. Older portions of extending roots possessing persistent root hairs of sub-epidermal origin were still absorbing on seedlings upward of three months old. Preliminary microchemical study of the relative abundance of essential mineral nutrients in these paths of absorption demonstrated that a decrease in chemicals tested occurred in mycorrhizal short roots. Earlier thickening of the endodermis in seedlings grown with known fungi in pure culture and in nursery soils under greenhouse conditions was found to be insufficient explanation of this difference. More extensive experiments under way will add final proof of the influences of mycorrhizae and pseudomycorrhizae on absorption of nutrient and resulting growth.

Cooperative Services.

The study of mycorrhizae from a cytological approach by I. Cohen, under a student assistantship supported by the Allegheny Forest Experiment Station, has been facilitated by the discovery of a new formula used for fixation and preservation. A mixture of reduced chromium in the form of chromic sulphate, as used in leather tanning, formaldehyde and salicylic acid, yielded the best results. Salicylic acid with formaldehyde was also found to have merit. Important evidence was obtained that chromium in the reduced form is superior to unreduced chromium in preservation formulae for phytopathological and normal specimens. So far the use of these newly discovered principles in the preservation of plant tissue for microscopic study has yielded important information about the fungus association of Liriodendron tulipifera. Many fine details of the association and the effect of the fungus on the root tissues of the trees have been more clearly brought out microscopically than with other methods. A report has been published.

A morphological study of compound mycorrhizae was made by A. Lisi under a student assistantship supported by the Allegheny Forest Experiment Station.

Systematic root studies have revealed the mycorrhizal association with a large number of forest trees. They are of various types but mostly simple forms consisting of single side roots, forked ("dichotomized") or sparsely branched systems of small roots. Occasionally more complex associations are found that have been designated compound mycorrhizae. In this study two species of pine, Pinus strobus, and P. rigida, and oak, Quercus prinus, were compared. A manuscript, in final form and covering the completed work, has been submitted for publication.

An ecological study of the relation between sporophore production of soil Hymenomycetes and Gasteromycetes, mycorrhiza formation and association of tree roots, was completed for one growing season by M. Barenbaum. The results of this study, based on a series of plots including various coniferous and hardwood mixtures and two plantations, are included in a detailed report.

Support of these studies by the Allegheny Forest Experiment Station at all times constituted a most important contribution to the project.

Maintenance of Culture Collection.

Cultures of all significant fungi, added to each year, have been maintained for future work.

Maintenance of Herbarium.

All known species of fungi in the culture collection are represented by sporophores in the herbarium. New methods of preserving delicate forms have been developed. These specimens furnished the basis for many determinations by mycologists specializing in the various groups of fungi.

Nursery Diseases. (B.P.I. Project 2P)(Dr. L.W.R.Jackson)

1. Certain physiological studies on the effect of hydrogen ion and aluminum ion concentration on damping-off diseases of coniferous seedlings were completed in 1932. It was found that the efficacy of acid treatments, as used for controlling damping-off diseases, is due in part directly to the increase in the hydrogen ion concentration in the soil. The smallest amount of damping-off occurred at the lowest pH values (pH 2.5-4.5) while exceedingly high percentages occurred at high pH values (pH 6.5-8.5). The results indicate further that the aluminum ion gives an added control effect only at high acidities.

These studies showed that the growth of the soil fungi causing damping-off, is affected directly by pH. None of the strains of Pythium, one of the most important parasites, would grow at either pH 2.5 or 3.5. Rhizoctonia grew at pH 3.5 but not at 2.5.

2. A study was made of the pathological anatomy of various types of damping-off diseases of coniferous seedlings in order to determine the way by which seedlings become infected. The results showed that most of the infections occurred primarily in the tap root and therefore damping-off is really a root rot disease. This work has been in progress since 1931.

3. During 1930 and 1931 the Delaware State Forest Nursery had a damping-off epiphytotic that made it virtually impossible to grow either red pine (Pinus resinosa) or white pine (Pinus strobus). In response to a request from State Forester Tabor a series of field and greenhouse experiments were initiated in order to find a satisfactory control measure. A large number of chemical fungicides were tested and the results showed that formaldehyde was the best. Formaldehyde has been used at the nursery since that date and they are now growing fully-stocked beds of the above-mentioned

species. Before they used this treatment their losses in seed alone amounted to $300.00 per season. Experiments are still in progress at this nursery.

4. During the summer of 1932 this office received a request from one of the nurseries in the Station's territory to investigate a disease prevalent amongst its red pine (Pinus resinosa). The disease was found to be a very destructive root and collar rot occurring chiefly on red pine seedlings and transplants. Investigations since that date have shown that the disease is caused by Phytophthora cinnamomi. It is a new nursery disease and the fungus has been held under suspicion as an introduction. A large number of cultures were made and Phytophthora appeared as the most important fungus associated with the disease. Studies were started on its pathogenicity. An extensive field survey failed to reveal the presence of the disease in any of the plantations examined in the Alleghany region. The growing of red pine at this nursery has since been discontinued.

During 1933 the research work on this red pine disease was taken over by the Washington Office. The disease still continues to cause heavy damages in the red pine beds at the nursery.

In 1934 the appointment of Dr. N. A. Norton on E.C.W. funds permitted the making of a systematic study of the regional occurrence and distribution of the red pine disease. The strain of Phytophthora responsible for it was not found, however, in any of the other forest nurseries in the Allegheny region. Some 10,000 isolations or cultures were made in this study. Dr. Norton's inspection of a large number of plantations - besides that of the nurseries - in Maryland and Pennsylvania failed to reveal a single new case of the resinosis disease. The field survey work benefited further by receiving the cooperation of Mr. Moses who was at that time conducting a general disease survey for E.C.W.

5. In April 1933 an investigation was made of a severe case of root trouble in the red pine and white pine beds at the New Jersey State Nursery. The preceding year's drought might have been a factor, but considerable damage seemed to be due to root rot. For this reason, although the disease did not resemble that mentioned above as occurring locally in a red pine nursery and caused by Phytophthora cinnamomi, its study was incorporated in the more general and farther-reaching research project on root rots.

6. In the spring of 1934 an investigation was made of the diseases that were causing considerable damage in the seedbeds of the Monongahela Nursery at Parsons, West Virginia. Disease control experiments have been conducted at this nursery since 1931. It has been found that either sulphuric acid or aluminum sulphate will adequately control damping-off diseases at this nursery. This experimental work is still in progress.

7. In 1933 and 1934 the Pennsylvania State Forest Nursery at Mont Alto, Pennsylvania, suffered heavy losses from damping-off diseases in certain areas. In response to a request from Professor Perry an experiment on control measures was started in 1934. A culture study was made in order to determine what parasites were present. In 1934 several series of pot tests with various fungicides were run at the Mont Alto Forestry School in cooperation with Professor Perry.

8. In 1933 and 1934 a damping-off and root rot epiphytotic occurred in the New Jersey State Nursery which was so severe that it completely destroyed the red pine and Scotch pine beds and greatly reduced production for the other species. The regular treatments with sulphuric acid and aluminum sulphate were apparently ineffective against this new disease. In cooperation with Mr. Kessler an investigation of the disease was initiated. In 1934 the red pine beds were sown twice. Both plantings were a total loss.

A series of new small scale greenhouse experiments for damping-off control, involving nearly 1000 cultures and expected to be far-reaching in the possible practical application of its results were started in 1934 by Mr. Mollenhauer, a Forest Service employee, on his own time. Each experiment comprised about forty 8" pots. The first series was run with Delaware Nursery soil, the second with soil from the Washington Crossing Nursery in New Jersey. Red pine was used exclusively as a host. The experiments with Delaware soil showed colloidal or milk sulphur to be worthless as a surface treatment after sowing. Hyper-humus, a seed covering material used at the Washington Crossing Nursery was found to be extremely detrimental to germination and emergence. A mixture of quartz and natural soil as a seed covering resulted in excellent germination and emergence and gave the best damping-off control.

It is aimed to continue these studies indefinitely as the methods of culturing developed affords a quick and easy means of obtaining the parasites that are active in the soil and of testing the efficacy of soil disinfectants. The experiments turn over about every six weeks.

These studies also revealed the presence of a hitherto unknown fungous parasite which is very destructive on most species of conifers and is very tolerant of high acidities.

9. Greenhouse studies started in 1934 and aiming at the development of new disinfectants for the control of nursery diseases, seem to point to salicylic acid as an effective fungicide against damping-off.

10. In 1934 a beginning was made with the development of a method for determining the rate of application of acidifying agents needed to change the reaction of any nursery soil, down to any depth, to any desired pH. Such a method will save considerable expense by eliminating a large amount of the field work necessary heretofore.

11. Several new nursery diseases were discovered during the 3 years covered by this report and studied as to their origins, causation, spread, and control. A large collection of cultures of fungi that cause nursery diseases is being maintained at this office.

12. During 1934 a very severe root rot disease appeared in the new beds of tulip poplar seedlings at the Monongahela Nursery at Parsons, West Virginia. The disease was diagnosed at this laboratory as being caused by Rhizoctonia. Control measures were recommended that stopped the spread of the disease and saved most of the stand.

13. Our cooperative and service activities, formerly limited to the nurseries in the Allegheny Region, since 1932 have become nationwide, including today work with and for the following nurseries: Susanville and Devils Canyon, California; Monument, Colorado; Halsey, Nebraska; Cass Lake and Cloquet, Minnesota; East Tawas, Michigan; Marietta, Ohio; and Henryville, Indiana. Numerous inquiries from several private nurseries have been received and disease control recommendations made.

14. Since 1932 a number of nursery diseases have been investigated as a result of inquiries from the various state agencies. The following is a list of these diseases:

(1) A stem resinosis disease on 3-year-old red pine at New Jersey State Nursery in 1933. Culture studies showed it was caused by Rhizoctonia and associated with too dense stands in the beds.

(2) A stem lesion disease on 3-year-old white pine prevalent at Greenwood Furnace, Pennsylvania, College Park, Maryland, Mont Alto, Pennsylvania, and causing considerable damage at certain times. It was diagnosed as a fungous disease that results from too densely crowded beds.

(3) A tap root rot of 1-year-old black walnut seedlings that is prevalent at practically all of our nurseries. Culture studies showed that it was caused by either Rhizoctonia or Phytophthora. Casued heavy losses in some cases.

(4) A top blight of 2-year-old red spruce (Picea rubra) has been prevalent in the Parsons Nursery, West Virginia, for several years. The cause of this disease is being investigated.

(5) Chlorosis or yellowing in the middle parts of the beds of coniferous seedlings. This is believed to be due to nitrogen deficiency in a majority of the cases. Most cases were corrected by applications of ammonium sulphate.

(6) Grub injury has been found to be the primary cause of a large number of the seed bed diseases reported, such as late dying, chlorosis and stunting.

Although the service to nurseries has heavily and continuously drawn on our time, we have gone as far as we possibly could to meet its demands. Investigations have been made, so far, of the disease cases reported in the order and to the extent of their relative importance, but in the very near future the investigative phase of this work will have to be curtailed and limited to such cases as are dangerous beyond a doubt or are new and therefore a potential menace.

Disease Survey (B.P.I. Project 1P2)(Dr. Jackson)

Several new forest tree diseases were found by this office during the years 1932 to 1934. A brief summary of the survey work follows: In 1932 Professor Perry of the Mont Alto Forestry School reported a severe

case of dying in the pine plantations of the Nolde Estate, Reading, Pennsylvania. In the summer of 1933 this office made its first inspection of the planting and found, amongst others, that the dying of the white and red pine was associated with a definite resinosis disease. Other investigations followed and numerous cultures of the suspected causative agents were made. From a survey which Dr. Norton made in 1934 of the entire estate it was concluded that the disease was the most serious epiphytotic in this area, and was threatening not only the estate's entire planting but also the success of its reforestation program. In order to study the rate of spread of the disease, one of the badly affected white pine plantings was charted, all the trees plotted and their conditions recorded. Notwithstanding the very great importance we attach to this case, it has been impossible for us to continue our work on it. The investigation should, however, be carried on.

A preliminary survey of the forest areas around the 12 CCC camps in the Region for tree diseases was started by us early in 1933, to be continued later by ECW appointees. Observations were made on canker diseases, timber decays, root diseases, twig blights, and improvement cutting methods. The following disease cases have been investigated and are considered as important in the region:

Twig and branch canker of certain hard pines, caused by the Atropellis group of fungi, Crumenula, Sclerroderris, and Cenanguim, which have done appreciable damage to Scotch pine plantations at Mont Alto, Pennsylvania, and in young stands of loblolly pine in Delaware from where the disease was first reported in 1931.

Canker diseases on the timber species of hardwoods, caused by Nectria, were found throughout practically the entire region.

A brooming disease on black locust and prevalent throughout the latter's range.

A severe case of dying in the pine plantations on the watershed at York, Pennsylvania, was reported in 1934 by Professor Perry. An investigation of it will be made in 1935.

A case of rosinosis disease on blue spruce in the Philadelphia area was reported and investigated by Mr. Wean. A further study of this disease is being conducted by him at the Morris Arboretum for the Botany Department of the University of Pennsylvania.

A widespread dying of the plane trees (Platanus orientalis) in Delaware County was called to our attention in 1932. Further investigations have shown that it is a dangerous disease and is threatening all the plane trees in the Philadelphia area. The work on this disease is being carried on with the assistance of Dr. Sleeth.

During 1933 Himalayan pine (Pinus excelsa) began to die over a wide area in the Philadelphia territory. The results obtained from field investigations indicate that this was due to winter injury.

For several years Austrian pine (Pinus austriaca) has been dying in the Philadelphia region on a large scale. Field investigations have shown that this is probably due to twig blight caused by Sphaeropsis ellisii.

General Inquiries on Tree Diseases (B.P.I. Project 1P1)(Dr. Jackson).

The number of general inquiries received by this office in 1934 almost suddenly leaped up to a very much higher level. In the 7th month of the current year it already had exceeded 50. The number of inquiries for each year since the office's establishment in 1930 follows:

Fiscal Year	Number of general inquiries
1930	1
1931	4
1932	11
1933	3
1934	2
1935	34
1935-36 (first 7 months)	59

This office seems to have become a clearing house for general inquiries from a large number of agencies in this Region interested either in forest tree or shade tree diseases or in both. With the limited funds available and the lack, therefore, of suitable assistance, it has been impossible, unfortunately, to do more than attend to the correspondence involved. Service has been extended to all of the State forestry departments.

We gratefully acknowledge the fine spirit of cooperation shown by the many who have helped in our work but wish to mention especially Drs. White, Whetzel, Welch, and Overholts in connection with our forest pathology project and Drs. Peterson, Wherry, True, Shive, and Livingston with our nursery disease control work.

Decay of Sprout Hardwoods (B.P.I. Project 3P)(Drs. Jackson and Sleeth).

The study of the butt rots in the second-growth hardwoods - chiefly oaks - of the Allegheny Region, with an emphasis on the question as to how decay is transmitted from sprout to sprouts and from the parent stump to the sprouts, although much retarded by a lack of logging due to the depression, has revealed the nature of many of the fungi responsible for both the heart and sap rots and their occurrence in the Station Region studied. An excellent opportunity to study these rots was offered in 1932 by the

cutting operations at Mont Alto Forest. The stumps there had been dynamited and pulled out by tractor allowing the dissection of entire stumps and roots and the making of cultures of the principal decays.

It has been observed that of the many decays we have thus learnt to recognize at sight Polyporus berkeleyi, Fomes everhartii, and Hydnum erinaceus are common heart rotters in the Philadelphia territory. Throughout the Region Polyporus connatus has been found to occur abundantly on open scars at the bases of maple trees. In most of the woods Stereum frustulosum is common on logs and stumps, but in only a few cases has it been found associated with living trees. Daedalia quercina occurs commonly on stumps and dead sprouts and is suspected of being an important heart rotter of sprout hardwoods throughout the Region. In the year 1933-34 a stump dissection study was made for the Logan Forest, Pennsylvania, and the Stokes Forest, New Jersey. No thinning having taken place for several years sprout groups had to be selected in which one or more sprouts had been dead for a number of years. Late in the summer of 1933 the ECW took over the hardwood sprout decay study, Dr. Sleeth carrying on the field work in New York, Pennsylvania, Maryland, and New Jersey.

The first attack in this project was to determine where the point of entry was of the fungi carrying the butt decays in hardwoods. The common points were the following:

1. The old or parent stump
2. Fire scars
3. Companion sprouts, either a dead one or one that was cut.

In a large number of sprout groups in which one or more of the sprouts had been dead for several years, the decay had entered at the crotch of the dead sprout and started down along the latter, only to end a short distance below. Also, in a number of cases decay had entered the

living sprout through a fire scar or the parent stump. In the latter two it had quite often died out before going very far up the sprout. The number of cases where the decay had been transmitted from the dead or cut sprout was surprisingly rare in the groups examined so far.

The field work up to this time has had to be confined to the State forests in the territory, dissection work having been done in the Pennsylvania, Bald Eagle, and Tuscarora Forests of Pennsylvania, the forests in western Maryland and during the last year in southern New Jersey. The various State and local foresters cooperated most heartily and rendered considerable assistance.

A brief summary of the findings up to the spring of 1934, exclusive of those in New Jersey, follows. Cases of hardwood rot were most frequently encountered in white, red, and rock oaks. Stereum gausapatum and S. frustulosum were the two fungi most commonly found associated with butt rot in the sprout groups examined.

Preliminary Summary

Point of Entrance of Heartwood Decays in Living Oak Sprouts

	Fungus	Quercus species				
		alba	coc- cinea	rom- tano	bore- alis	velu- tina
Decay entering living sprout from dead or cut sprout	S. frustulosum	2				
	S. gausapatum	6			2	
	Irpex crassa	1				
	D. quercina	1				
	Unidentified #	5				
Decay entering sprout from old stump	S. frustulosum		1			
	A. mellea	3		1		
	Unidentified #	4	4	4	3	
No infection of living sprout but decay entered at crotch	S. gausapatum	2				
	S. frustulosum	5			2	
	P. versicolor		1			
	D. quercina			1		
	D. sprucei ?				1	
	F. annosus ?				1	
	Unidentified #	27	5	12	19	2

In most of the unidentified decays no cultures were made because often only a very small portion of the dead sprout had decayed below the crotch.

Another phase of the hardwood decay project was studied later in 1934, namely, the determination on an acreage basis of the number of trees infected with butt rot and the number of non-infected trees and the factors concerned in high and low decay hazard. From an economic as well as a pathologic viewpoint it is desirable, before the formulation of a practical oak sprout cutting program can be undertaken, to know the amount of butt rot that may be expected in the 4 most common types of growth conditions and the factors concerned, (1) sprout stands damaged some time by fire, (2) sprout stands not so damaged, (3) stands of seedling origin, damaged by fire, and (4) such stands untouched by fire. For this purpose data were collected from two different kinds of sources: (a) clear-cut 1/4-acre plots of young sprout oak growth and (b) active logging operations. Areas selected for study were free from fire damage or only lightly burned. Of the 1/4-acre plots cut 4 were located in New Jersey - 3 on the Bass River State Forest and one in the Newark City Watershed Forest - and 4 in Pennsylvania - 3 in the Bald Eagle State Forest and 1 on private property near Dix. The sites of the 3 logging operations studied intensively were Rockville, Maryland, Mifflinburg, Pennsylvania, and McAlevys Fort, Pennsylvania.

That Stereum gausapatum is the most common decay organism in the infected sprout hardwoods of the Region was confirmed by these studies. The isolation work on these organisms was done by Mr. Ross W. Davidson, Washington, D. C. The point of entrance invariably was from the parent stump, entrance from other points as fire scars being negligible, as the areas studied were practically free from fire burns. In the New Jersey plots on the Bass River Forest, Fistulina hepatica was common; it was found to cause a dark mahogany-like discoloration at the base of the sprouts. Infec-

tion by other fungi was small, the more important one being Armillaria mellea and found confined chiefly to isolations from the old stump.

On the eight 1/4-acre plots 934 sprouts were cut. Butt rot infection here ranged from 0 to 18% per plot. The average age of the stands in which the plots were situated ranged from 16 to 35 years.

Of the logging operations in Maryland and Pennsylvania only 3 yielded data suitable for further study and of these the data for McAlevys Fort, which has a 90 to 100% sprout reproduction, may perhaps be considered the only ones typical of sprout reproduction stands. As is indicated by the very few cull butts left by the timber cutters in the woods the economic loss due to butt rot at the latter location, a fire free 80-year old stand was not high. However, butt rot was found in 30 to 40% of the stumps dissected on a 1/4-acre plot. It is highly probable that in 10 to 20 years from now considerable loss would have been caused in this stand by butt rot.

Mr. R. C. Lorenz assisted in doing some of the Strumella inoculation work carried out in the Logan State Forest near Sand Spring in October 1934. A large number of inoculations was made on various oak species with different Strumella isolants.

Branch Stations

The time has come to formulate a comprehensive and orderly plan for the development of an adequate system of branch stations, or centers of field work.

In the establishment of branches we have hitherto been limited by the amount of money available for the erection of improvements on them, and for the maintenance of a resident caretaker. Only one branch station - that at Kane, Pa. - is adequately equipped and under yearlong resident supervision; the Lebanon (N.J.) Branch Station has only two buildings, and has no permanent caretaker. Opportunities now present themselves to acquire (with State approval) experimental forests even in those of our four States having no enabling act for National Forest purchase, and to improve and to man them from temporary funds as branch stations.

The problem is how to provide adequate facilities in the woods for the study of a great diversity of conditions, without unduly multiplying our investment and scattering our effort. This diversity is both physical and economical. In about 22-1/2 million acres of forest land, of abandoned agricultural land available for forestry, 3 of the 8 important forest types of the East are represented, roughly in the following areas (See Map):

Oak-Chestnut-Yellow Poplar	13-1/2 million acres
Beech-Birch-Maple-Hemlock	5 " "
Oak-Pine	4 " "

Economic conditions are in some respects as diverse as the natural conditions. The commercial market for fuel wood, for example, in southern New Jersey is excellent, but is non-existent elsewhere except in surburban districts demanding hearth wood. Markets are similarly localized for distillation wood, pulpwood, and mine props. Because of the absence of small sawmills, saw timber as such is hardly salable in some districts. The "intangible" values of the forest based on recreational use and watershed influence vary with

locality from moderate to very high. In general, however, few regions have better markets for forest products, or higher recreational and watershed values, than this Station's territory. Conditions in the major forest types, so far as they affect the problem of branch station location, are as follows:

Oak-Chestnut-Yellow Poplar type. This type is generously represented in the Station territory and in area stands first in importance. Its acute problems, which should be studied at suitably located branch stations, are:

(1) Improvement and regeneration of second-growth stands now generally deficient in trees of seedling origin.

(2) Restoration to commodity production of about 2,000,000 acres reduced by over-cutting and fire to scrub oak and similar species.

(3) Forest influences on erosion and streamflow in a region where domestic and industrial water supplies, waterpower, navigation, and floods are of great importance.

(4) In the anthracite coal region forest fires. This region shares with south Jersey an unenviable reputation as the most heavily burned area in the northeastern United States.

Among the physical factors which cause the forest to vary within this type are: elevations from sea level to over 3,000 feet above it; some 20 geologic formations, varying in age and character from Pre-Cambrian crystalline rock to Tertiary marls, which give rise to correspondingly varied soils; an average growing season of from 135 to 210 days; an average annual precipitation from 34 to 50 inches.

The range of soil and climatic conditions, and the variety of products and services required of this type of forest, suggest the need for several branch stations in the oak-chestnut-yellow poplar type. Extensive surveys are planned to determine the ultimate number and their location, but there is little doubt that two should be established immediately. The first proposed is in Huntingdon County, Pennsylvania, near State College (location 3 on the attached

map, the existing Lebanon and Kane Branches representing locations 1 and 2). This situation has the great advantage of offering field contacts not only with the only forest school in our territory, and with the only State Experiment Station which conducts forest research as such, but also with the Pennsylvania Department of Forests and Waters, which has a district headquarters at Petersburg. A second location, somewhere in the anthracite coal region, where all four of the problems listed above are particularly acute, is indicated roughly by the figure 4. The establishment of this branch station in the drainage area of the Delaware River would fit our work into the comprehensive Federal plans for developing this watershed, as set forth in the 1934 report of the President's Committee on Water Flow (House Document 395, 73d Congress, 2d Session).

Tentative locations for additional branches (6 and 9) in the oak type include the bituminous coal region on the watershed of the Ohio River, and in northern New Jersey, where forest land has a very high value for both recreation and watershed protection.

The bulk of the commercial oak-chestnut-yellow poplar type, which furnishes both the anthracite and the bituminous coal industries with mine props, and the pulp industry with pine pulpwood, is located in our territory at elevations above 1,000 feet, in regions where farming has been steadily losing ground for many decades. A special study of intensive farm forestry has been suggested to us by Mr. A. B. Ross, who is thoroughly acquainted with farming practices in southwestern Pennsylvania, and who maintains that failure of many farmers to make ends meet in this territory is not due to impossible conditions of soil and climate, but to an uneconomic handling of their own farms. The average farmer, Mr.Ross contends, attempts to farm 50 to 100% more land than he can really handle. By reducing his farmed acreage to what he can efficiently handle, and by raising quick-growing crops of pulpwood and mine props on the remainder, Mr. Ross believes that it is possible for the farmer to utilize teams and hired help effectively throughout the year, and in so doing turn his

sub-marginal farm into a marginal one. Under this plan he would prepare the land for his forest crops with something like the thoroughness with which he prepares other land for his farm crops; would clean, thin, prune, and otherwise handle the young crop intensively; would build up soil fertility by the use of black locust; and might expect to begin harvesting the wood crop within 15 years. A most appealing feature of the above plan is the maintenance of a rural population on a substantially higher plane of living than the same individuals are likely to attain elsewhere. From a forestry standpoint the plan is well worth investigation, because of the large demand in our territory for small-sized material, because comparatively fertile ground and intensive silviculture would permit of exceptionally short rotations, and because only the maintenance of a rural population provides labor for fire protection and intensive forest management. A branch station in the oak-chestnut-yellow poplar type could in our judgment very wisely concentrate on exploring the intensive silvicultural methods envisaged in this plan. Its location somewhere in the oak type of southwestern Pennsylvania or western Maryland is indicated by the numeral 6.

Oak-Pine type. The 4,000,000 acres of oak-pine in the Allegheny Station territory represent only a small portion of a widely-distributed type. Nevertheless, as on Long Island and Cape Cod to the north, our oak-pine forests occur on a different physiographic province, with corresponding differences in soils, from the bulk of the type to the south.

This is a type of great contrasts in the Station territory. The oak-pine forests of south Jersey, occupying large unbroken areas, are closer to an enormous metropolitan population than any comparable area of forest in the United States, and have corresponding potentialities for recreational use - including hunting - and water supply. At present, however, they are in a highly degraded condition (the white cedar swamps, site of some of the most intensive silvicultural operations in the United States - conducted on a few acres of State forest land - are only a small sub-type). The chief silvicultural problems

are those of rehabilitation, by intensified system of fire protection and by aggressive stand improvement work, including interplanting. The chief native species concerned are pitch and shortleaf pines and the white oaks. On the Delaware-Maryland-Virginia peninsula agriculture overshadows recreation, and old-field stands of loblolly pine are among the most productive forest areas in the Station territory. The abandonment of poorer farm land on a considerable scale is adding to the area of continuous forest. On land never cleared sweet gum and other hardwoods are an important part of the mixture. Measures of relatively intensive silviculture, made possible by the demand for at least the pine in many forms - lumber, veneer, piling, mine props, pulpwood - claim first attention on any forest research program. A very specialized problem of no mean importance is the management of Christmas holly, which under ordinary commercial harvesting is on the high road to extinction. A third and distinct phase of the oak-pine type occurs on the western shore of Chesapeake Bay in Maryland. Its chief conifer is Virginia pine, and the hardwoods are mostly upland oaks. Agriculture, recreation and commercial lumbering for a variety of products but particularly pulpwood are all important land uses, and erosion of cleared slopes is extraordinarily serious for a non-mountainous region. Forest problems include stand improvement, regeneration with particular emphasis on restoration of a better balance between pine and hardwoods, and planting to control erosion.

The number and location of branch stations in the oak-pine type are largely dictated by these marked variations in the type. At the present time the pines overshadow the oaks in importance in all three geographic divisions of the type. The Lebanon Branch Station is already established in south Jersey. Although Virginia pine has attained wide use in pulp manufacture, and is abundant on old fields not only within, but also far beyond, the limits of the oak-pine type (there are 250,000 acres of old fields reforested by it in Pennsylvania alone), loblolly pine is used in many more forms, and is probably the most valuable species in the present forests of the Allegheny region. A branch to

study it and its associates, (at some such point as 5, on the Eastern Short of Maryland) is the last of the three recommended for immediate development.

Some of the oldest permanent sample plots of the Forest Service, unfortunately on private land, have given us an unusual start at or near this location. A third branch station in the oak-pine type is justified only after the establishment of another branch in the much more extensive oak-chestnut-yellow poplar type. Location 7, at the new Departmental research center near Beltsville, Md., would be suitable for silvicultural studies, but is probably too far inland to include areas typifying the erosion problem of the western shore of Maryland. However, because of the opportunities it offers for coordination of our research with that of other bureaus of the Department, it is to be recommended.

Beech-Birch-Maple-Hemlock type. This type for many years supported a great lumber industry and even today probably produces more lumber than the other two types combined. It is also the source of raw material for the important hardwood distillation industry, and supports several substantial pulp mills. Some of the best hunting in the State of Pennsylvania is found in its great areas of unbroken forest. The problems of forest management include the improvement and regeneration of second-growth stands from which the very valuable softwood elements have all but disappeared under heavy cutting and fire; the restoration to commodity production of a half million acres of aspen and fire cherry; attainment of a proper balance between timber and game production; and forest influences. Erosion-streamflow problems arise out of floods, particularly in the Allegheny River watershed, and increasing water power development, in part resulting from gradual exhaustion of the natural gas of northwestern Pennsylvania.

The Kane Branch Station's facilities for study of unglaciated portions of this type have been greatly increased by the Federal purchase of the Heart's Content and Tionesta Forest virgin areas. They may be supplemented further if necessary by withdrawals from the surrounding Allegheny National Forest with much less difficulty than if the branch station were surrounded by non-Federal

land. Only one other branch in the type seems necessary - that at location 8 - or elsewhere in the glaciated portion. The order of its establishment relative to that of the two stations just discussed (locations 7 and 9) in the other two types can well be left to a later decision, and may be affected by the branch station program of the Northeastern and Appalachian Stations.

Summary. The program of branch station development above recommended may be summarized as follows, the branches being numbered in order of importance:

Oak-pine type (4,000,000 acres)

1. Lebanon Branch Station. Established. Southern New Jersey (Chief species: pitch pine, the white oaks)

5. Delaware and eastern shore of Maryland (Chief species: loblolly pine, red gum)

7. Western shore of Maryland (Chief species: Virginia pine, mixed hardwoods)

Beech-birch-maple-hemlock type (5,000,000 acres)

2. Kane Branch Station. Established. Northwestern Pennsylvania (unglaciated)

8. North central Pennsylvania (glaciated)

Oak-chestnut-yellow poplar type (13,500 000 acres)

3. Stone Valley, Huntingdon County, Pennsylvania, in cooperation with State College and Pennsylvania Department of Forests and Waters

4. Anthracite coal region, Delaware River watershed, Pennsylvania

6. Bituminous coal region, Pennsylvania

9. Northern New Jersey, municipal watershed

Provided funds for their improvement can be anticipated, Branches 3, 4, and 5 are recommended for immediate establishment. An experimental forest at Location 4 would probably have to be purchased, but at locations 3 and 5 submarginal farm lands are being acquired by the Agricultural Adjustment Administration. The State forestry departments concerned are favorable to our establishment of branches at all three locations.

How to acquire the remaining sites is not an immediate problem, but should be given preliminary consideration. In the case of the branch station on the

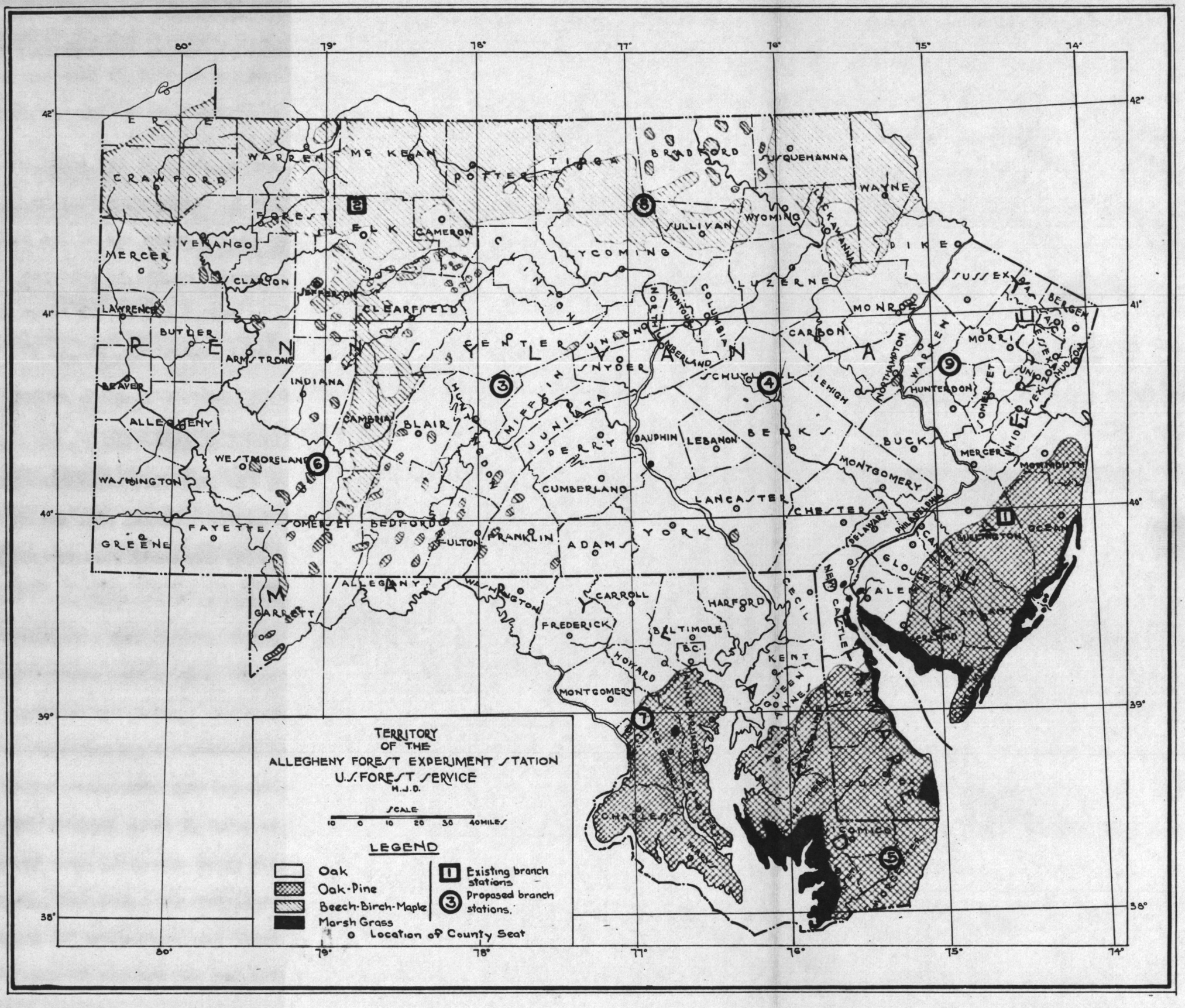
western shore of Maryland, the imminent expansion of the Departmental Research Center at Beltsville, promises to simplify the acquisition problem. The desirability of keeping in touch with all Federal agencies contemplating purchase of forest land is obvious.

Advisory Council

The Council's comparative inactivity during the past few years has been almost entirely due to the Director's inability to devote more time to its affairs, as secretary. The interest shown by nearly every one of its members with whom the Director has come in contact in recent months is evidence that the Council has but to organize more effectively to become a powerful force in promoting forest research not only by the Federal government, but by State and other agencies.

RESEARCH PROJECTS

Inasmuch as the annual report covering the Station's activities during 1935, due to the late date of publishing the report in hand, will follow in the very near future, a discussion of the work on the Station's research projects for the ensuing period has been omitted.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ARMSTRONG
INDIANA
SNYDER
UNION
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BERKS
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LEGEND
Oak
Oak-Pine
Beech-Birch-Maple
Marsh Grass
Location of County Seat
Existing branch stations
Proposed branch stations.

Manuscripts Published

Author	Title of Manuscript	Name of Publication	Date of Issue	Remarks
Doak, K. D.	Mineral requirements of Tilia and Quercus	Proceedings Pennsylvania Academy of Sciences	1933	Studies completed before 1930
" "	Culture methods used in endothrophic mycorrhiza investigations			
" "	Comparison of mycorrhizal structure in Vaccinium, Gaylussacia, and Chamaedaphne			
" "	Mycorrhizae and their relation to shade trees	Proceedings 10th National Shade Tree Conference	Aug. 1934	
" "	Cortical parasitism of conifer seedling roots in pure culture by mycorrhizal and non-mycorrhizal fungi	Phytopathology	1934	24:6
" "	Fungi producing mycorrhizae of conifers	Phytopathology	1934	24:8
Forbes, R. D. (Co-author)	Watershed and related forest influences	Senate Document No. 12, 73rd Congress, 1st Session (Copeland Report	1933	
Forbes, R. D.	How to stop forest devastation			
" "	The thousandth acre	American Forests	Feb. 1934	
" "	Ruling the river	Scientific Monthly	June 1934	
Hatch, A. B.	Pure culture technique for quantitative studies of plant growth in association with micro-organisms	Phytopathology	Jan. 1933	Abstract
" "	True mycorrhizal fungus in contrast to Mycelium radicis atrovirens	Phytopathology	Jan. 1933	Abstract
" " and Doak, K. D.	Mycorrhizal and other features of the root systems of Pinus	Journal of the Arnold Arboretum	1933	Vol. XIV

Manuscripts Published (continued)

Author	Title of Manuscript	Name of Publication	Date of Issue	Remarks
Hough, A. F.	Some diameter distributions in forest stands of northwestern Pennsylvania	Journal of Forestry	Dec. 1932	
" "	Virgin forest in Pennsylvania yields research results	Forest Worker	Mar. 1933	
" "	Natural enemies of the forest	Forest Leaves	Jan. 1934	
Schnur, G. L.	Mortality in old-field loblolly pine	Forest Worker	May 1932	
" "	Converting factors for some stacked cords	Journal of Forestry	Nov. 1932	
" "	Review of "Perfecting a stand-density index for even-aged forests" by L. H. Reinecke in Journal of Agricultural Research, April 1, 1933	Journal of Forestry	Mar. 1934	
" "	Diameter distributions for old-field loblolly pine stands in Maryland	Journal of Agricultural Research	Oct. 15, 1934	
Wood, O. M.	An example of white pine reproduction on burned lands in northeastern Pennsylvania	Journal of Forestry	Nov. 1932	
" "	Litter cover and soil surface temperatures, oak-pine type	Station Technical Note No. 3	Apr. 1933	Mimeographed
" "	Acorns from the same tree tend to be uniform	Forest Worker	July 1933	
" "	The root system of a chestnut oak	Proceedings 10th National Shade Tree Conference	Aug. 1934	
" "	A brief record of seed productivity for chestnut oak in southern New Jersey	Journal of Forestry	Dec. 1934	

Manuscripts Submitted

Author	Title of Manuscript	For publication in:	Remarks
Doak, K. D. and Cohen, Isadore	The fixing and staining of Liriodendron Tulipifera root tips and their mycorrhizal fungus	Stain Technology	(Published Jan. 1935)
Doak, K. D. and Fisher, P. L.	Influence of environment on relation between mycorrhizae and pseudomycorrhizae of Pinus	Phytopathology	
Doak, K. D. and Norton, N. A.	Morphological continuities in mycorrhizae of Fagus, Quercus, Ulmus, Betula, and Juglans	American Journal of Botany	
Forbes, R. D.	Review of "Ecological relations in the pitch pine plains of southern New Jersey," by H. J. Lutz, Yale School of Forestry Bulletin 38	Yale Forest School News	(Published Jan. 1935)
" "	Tionesta Forest	New York Times, Sunday Edition	(Published Jan. 6, 1935)
Hough, A. F.	A climax forest community on East Tionesta Creek in northwestern Pennsylvania	Ecology	
" "	A method of preparing wood sections for accurate age counts	Journal of Forestry	
Jackson, L. W. R. and Randall, B. S.	A Phytophthora root and collar rot of Pinus resinosa seedlings	Phytopathology	
Jackson, L. W. R. and Sleeth, Bailey	A new disease affecting Platanus orientalis in the eastern United States	Phytopathology	
Lisi, A. G.	A reticulated Amanita muscaria	Proceedings, Pennsylvania Academy of Sciences	(Published Mar. 1935-9:86)
Lisi, A. G. and Doak, K. D.	A morphological comparison of compound forms of mycorrhizae	American Journal of Botany	

Manuscripts Submitted (continued)

Author	Title of Manuscript	For publication in:	Remarks
McIntyre, A. C. and Schnur, G. L.	The effect of the 1930 drought on some stands in central Pennsylvania	Pennsylvania State Agricultural Experiment Station Bulletin	
Morey, H. F.	A comparison of two virgin forests in northwestern Pennsylvania	Ecology	
Schnur, G. L.	Yield, stand, and volume tables for even-aged upland oak forests	Technical Bulletin, U. S. Department of Agriculture	
Simmons, E. M.	Pruning and thinning a white pine plantation in the southern Appalachians	Journal of Forestry	(Published May 1935)
Wood, O. M.	Removal of the forest affects local climate and growing conditions	U. S. Department of Agriculture Yearbook, 1935	(Published)

Expenditures from Regular and Emergency Funds

of the

Allegheny Forest Experiment Station

Fiscal Year 1933

Research Projects and Improvements	Regular Station Funds	Emergency Funds E.C.W.	Total Expenditures
Fp - Planting	$ 736.88	$	$ 736.88
M-1 - Allegheny Hardwoods	13,157.12		13,157.12
M-3 - Coastal Plain	5,354.16		5,354.16
ME-1 - Oaks	3,230.44		3,230.44
ME-2 - Coastal Plain	2,868.37		2,868.37
Pd-1 - Mycorrhizae	642.91		642.91
Special Studies	187.84		187.84
Improvements		6,392.22	6,392.22
Total	$26,177.72	$ 6,392.22	$32,569.94

Expenditures from Regular and Emergency Funds

of the

Allegheny Forest Experiment Station

Fiscal Year 1934

Research Projects and Improvements	Regular Station Funds	Emergency Funds			Total	Total Expenditures
		E.C.W.	N.I.R.A.	C.W.A.		
Fp - Planting	$ 163.59	$	$	$ 215.52	$ 215.52	$ 379.11
M-1 - Allegheny Hardwoods	9,829.38	413.06	225.54	3,848.31	4,486.91	14,316.29
M-3 - Coastal Plain	4,333.10			1,566.02	1,566.02	5,899.12
ME-1 - Oaks	2,579.73			944.86	944.86	3,524.59
ME-2 - Coastal Plain	2,094.55			838.96	838.96	2,933.51
Pd-1 - Mycorrhizae	204.26			188.04	188.04	392.30
Special Studies	1,600.70			54.93	54.93	1,655.63
Improvements			3,242.46	1,589.00	4,831.46	4,831.46
Totals	$20,805.31	$413.06	$3,468.00	$9,245.64	$13,126.70	$33,932.01

Expenditures from Regular and Emergency Funds

of the

Allegheny Forest Experiment Station

Fiscal Year 1935

Research Projects and Improvements	Regular Station Funds	Emergency Funds				Total Expenditures
		E.C.W.	N.I.R.A.	L.W.D.	Total	
Fp - Planting	$ 665.37	$	$	$	$	$ 665.37
M-1 - Allegheny Hardwoods	10,277.57	5,889.26	2,139.72	230.65	8,259.63	18,537.20
M-3 - Coastal Plain	4,643.97	2,165.65	2,081.83	819.00	5,066.48	9,710.45
ME-1 - Oaks	4,163.49			232.80	232.80	4,396.29
ME-2 - Coastal Plain	1,555.47	887.42	1,754.14		2,641.56	4,197.03
Pd-1 - Mycorrhizae	382.91			657.50	657.50	1,040.41
Special Studies	1,154.25			566.50	566.50	1,720.75
Improvements			6,745.06		6,745.06	6,745.06
Total	$22,843.03	$8,942.33	$12,720.75	$2,506.45	$24,169.53	$47,012.56

Comparative Regular, Emergency, and Total Expenditures

of the

Allegheny Forest Experiment Station

for the

Fiscal Years 1933-'34-'35

Research Projects and Improvements	1933			1934			1935		
	Regular Funds	Emergency Funds	Total	Regular Funds	Emergency Funds	Total	Regular Funds	Emergency Funds	Total
Fp-- Planting	$ 736.88	$	$ 736.88	$ 163.59	$ 215.52	$ 379.11	$ 665.37	$	$ 665.37
M-1 - Allegheny Hardwoods	13,157.12		13,157.12	9,829.38	4,486.91	14,316.29	10,277.57	8,259.63	18,537.20
M-3 - Coastal Plain	5,354.16		5,354.16	4,333.10	1,566.02	5,899.12	4,643.97	5,066.48	9,710.45
ME-1 -- Oaks	3,230.44		3,230.44	2,579.73	944.86	3,524.59	4,163.49	232.80	4,396.29
ME-2 - Coastal Plain	2,868.37		2,868.37	2,094.55	838.96	2,933.51	1,555.47	2,641.56	4,197.03
Pd-1 -- Mycorrhizae	642.91		642.91	204.26	188.04	392.30	382.91	657.50	1,040.41
Special Studies	187.84		187.84	1,600.70	54.93	1,655.63	1,154.25	566.50	1,720.75
Improvements		6,392.22	6,392.22		4,831.46	4,831.46		6,745.06	6,745.06
Total	$26,177.72	$ 6,392.22	$32,569.94	$20,805.31	$13,126.70	$33,932.01	$22,843.03	$24,169.53	$47,012.56